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OU-1 TREATED MATERIAL TRANSPORTATION REPORT SUPPORTING STUDY 4.0, OPERABLE UNIT 1, PROJECT ORDER 93, SEPTEMBER 10, 1993, REVISION 1, FINAL ISSUE - (USED AS A REFERENCE IN OU1 FS REPORT)

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PARSONS
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REPORT

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OU-1 Treated Material Transportation Report Supporting Study 4.0

Operable Unit 1
Project Order 93
September 10, 1993
Revision 1, Final Issue

Environmental Remedial Action Project
Fernald Environmental Management Project
Fernald, Ohio
FERMCO Subcontract No. 2-21487

Fairfield Executive Center
6120 South Gilmore Road
Fairfield, Ohio 45014

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OU-1 Treated Material Transportation Report
Supporting Study 4.0

CONTENTS

SECTION

CONTENTS (Continued)

APPENDICES

000004

LIST OF ILLUSTRATIONS

FIGURES

TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

ARAR	Applicable or Relevant and Appropriate Requirement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COE	U.S. Army Corps of Engineers
CRU	CERCLA/RCRA Unit
DOE	United States Department of Energy
DOE/NV	United States Department of Energy Nevada
DOT	United States Department of Transportation
ERA	Environmental Remedial Action
FEMP	Fernald Environmental Management Project
FERMCO	Fernald Environmental Restoration Management Corporation
FFCA	Federal Facility Compliance Agreement
FMPC	Feed Materials Production Center
ft^3	cubic feet
km	kilometer
LLRW	Low-Level Radioactive Waste
LSA	Low Specific Activity
NORM	Natural Occurring Radioactive Material
NTS	Nevada Test Site
OCRWM	Office of Civilian Radioactive Waste Management
OU	Operable Unit
PO	Project Order
REECo/WMD	Reynolds Electrical & Engineering Co., Inc. Waste Management Department
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
TBC	To Be Considered
TLDB	Transportation Legislative Data Base
US EPA	United States Environmental Protection Agency
yd^3	cubic yards

SECTION 1

INTRODUCTION

1.1 Objective

One potential remedial alternative for Operable Unit 1 (OU-1) includes off-site disposal of the treated waste material. This document is a supporting study that will be used during the evaluation of the identified OU-1 area at the Fernald Environmental Management Project (FEMP). It is the objective of this study to identify and evaluate potential modes and routes for the shipment of treated OU-1 wastes from the FEMP to three off-site disposal sites. The document integrates other non-PARSONS transportation data, facility waste acceptance criteria, and Federal and State regulations. The shipment routes and modes are evaluated primarily in terms of risks and costs and, secondly, from a regulatory standpoint. The results of this study are intended to assist site planners in selecting the safest and most cost-effective means of shipping OU-1 wastes off site, should off-site disposal be selected as the remedial alternative for OU-1. It is anticipated the conclusions drawn from this transportation study will establish a basis for future transportation documents considered at the FEMP.

1.2 Approach

Risks and costs were evaluated for routes and modes of shipment to three locations. While no off-site disposal location has been selected, three locations have been specified by Fernald Environmental Restoration Management Corporation (FERMCO) for the purposes of this analysis because they are representative of all possible locations. The three locations are the Nevada Test Site (NTS) northwest of Las Vegas, Nevada; the Envirocare Facility near Clive, Utah; and the Piketon United States Department of Energy (DOE) reservation 20 miles north of Portsmouth, Ohio. (Note that the Piketon DOE reservation has no disposal capability; it was specified only for purposes of analysis. This site is referenced throughout this document as the Portsmouth site.) Truck and rail were the only two transportation modes evaluated in this document. The risks of different routes were evaluated by selecting the (two) most likely highway and rail routes to each of the three specified disposal locations, including any routes currently used for waste shipments from the FEMP. A Sandia National Laboratory computer code (RADTRAN 4) was used to determine the occupational and public risk of each route from radiation and accidents. A cost analysis was performed on the least risky highway and rail routes to each location.

1.3 Assumptions

The following list of assumptions establish the basis for transportation logistics, cost, and risk parameters that are necessary for this study.

1.3.1 Transportation Logistics

1) The FEMP treated waste will be fully accepted for permanent disposal at Portsmouth. The Portsmouth waste acceptance criteria are the same as those for Envirocare. A rail spur is available at the Portsmouth facility.

2) The waste, in whatever form, will meet the identified waste acceptance criteria at each specified disposal site.

3) The waste acceptance criteria listed in the "Identification of Transport and Waste Acceptance Criteria Impacting Shipment of Fernald Environmental Management Project Pit Wastes" (SAIC 1992) reference report is accurate and was only reviewed for additional criteria since the publication date.

4) Unless otherwise stated, all identified state Applicable or Relevant and Appropriate Requirements (ARARs) in the FERMCO provided "Draft Off-Site Disposal Transportation Requirements" (see Subsection 3.1) pertain to the transportation of Low Specific Activity (LSA) material; however, each applicable regulation should be verified by reviewing the actual definitions of regulated material in state regulations.

5) All waste boxes or containers will satisfy all applicable transportation regulations and will be transportable by truck or rail. These boxes are called United States Department of Transportation (DOT) "Strong Tight Containers."

6) All shipments are made to a single destination by a single mode (truck or rail). The one exception is that truck drayage is required for the rail transport option between Las Vegas and the NTS. There is no direct rail connection to the NTS, and therefore truck drayage is necessary. (Drayage is a term used throughout this document that addresses the unloading of containers from rail cars to trucks before reaching the final destination.)

7) No other mode of transportation (e.g., water, air, etc.) other than truck or rail is considered in this report.

8) If rail is used, the rail track at the FEMP site will be appropriate for regular, high-volume movements within the site and to the nearby storage yard. A locomotive or car mover will be readily available to move and spot cars.

9) If trucks are used, the road system at the FEMP site will be appropriate for regular, high-volume movements within the site and to a nearby highway. A yard tractor will be readily available to move and spot trailers. All other tractors will be supplied by the truck carriers.

10) State and local regulations will allow normal transportation operations and routings identified in the RADTRAN program.

11) Waste packages will be blocked, braced, and/or rigged to the vehicle for safe transportation consistent with applicable Federal, State, or other regulations.

12) Truck and rail shipments will use common carriers.

13) For truck and rail loading and unloading, all waste containers have similar size, weight, and radiological characteristics.

14) The treated waste will not be shipped as "special form." Special form materials are those that, if released from a package, might present a hazard of direct external radiation.

15) Waste packages will be buried with contents at the NTS and Portsmouth sites. Reusable containers can be used 50 times where applicable.

1.3.2 Risk and Cost Assumptions

1) Handling and disposal costs at each disposal site are not included in the transportation cost analysis. Handling costs at the FEMP to package and load the waste into truck trailers or rail cars are included in the cost equations.

2) All shipments will move under contract with truck or rail carriers. The selected carrier will provide complete service to the FEMP to transport waste. Rates negotiated to reflect high volume and consistent service are not reflected in this analysis. No buying or leasing of transportation equipment will be costed.

3) The cost analysis evaluates the effects of changing waste volumes on transportation costs. The analysis is based on three different volume scenarios for different container types. Refer to Subsection 1.4 for various waste densities used in the cost analysis.

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4) The risk assessment selects the route to disposal sites. The cost analysis is based on the selection of these routes for truck and rail.

5) There are no criticality concerns involving the transportation of FEMP OU-1 waste.

6) The risk assessment is based on the shipment of 1 million cubic yards of treated (i.e., dried, vitrified, or encapsulated in polyethylene) waste volume. The stated risk densities will affect the number of shipments which will impact radiological and accidental risks associated with the transportation of the waste. Existing FEMP transportation truck and rail routes were used as the baseline case for comparison with computer selected routes.

1.4 Treated Waste Forms

All debris generated from the waste pit area are assumed to be LSA material. Radiological wastes exist in all pits. Waste Pits 4 and 5 have been designated as containing mixed waste. A mixed waste contains both hazardous and radiological constituents. As directed for the purpose of this study, only the radiological considerations were addressed. In each instance, the radioactivity is essentially uniformly distributed and in relatively low concentrations. The LSA material is assumed to not contain hazardous constituents as mixed waste is not considered within this study.

The excavated materials from the waste pits, which could swell by about 12 percent over their in situ volume, would potentially be treated in one of the following methods: dried, vitrified, or encapsulated in polyethylene. The first method of treatment, dried (i.e., removal of moisture), would have little impact on the total excavated waste volume. It is anticipated that encapsulation of the material would increase the treated waste volume and would provide a stable waste form. The polyethylene encapsulation could increase the volume up to 50 percent. Depending on the formulation, the pit wastes encapsulated in polyethylene would provide a homogeneous matrix similar to concrete. Vitrification could potentially decrease the final waste volume, depending on the source and amount of glass-forming additives. If the vitrified waste end product is glass block, then the waste volume would be approximately the same as that of the dried material. If the vitrified waste end product is in the form of glass frit, then the product would increase by approximately 40 percent over the initial waste volume.

The densities listed below are important as they will impact the risk assessment and cost analysis from the standpoint of the additional number of shipments that are required.

1) 100 lbs/ft^3 for shipping dried material
2) 125 lbs/ft^3 for granular material (e.g., solid chunks, glass frit, and gems)
3) 180 lbs/ft^3 for glass blocks
4) 125 lbs/ft^3 for polyethylene encapsulated waste forms

SECTION 2

BACKGROUND INFORMATION

The Feed Materials Production Center (FMPC) began operations in 1951 under the orders of the Atomic Energy Commission. The FMPC was established to produce uranium and other metal products for use at various DOE nuclear weapons facilities. Production operations at the site ended in 1989, and the site was renamed the Fernald Environmental Management Project (FEMP) in 1991. The FEMP is located near Fernald, Ohio, approximately 20 miles northwest of Cincinnati, Ohio. The production facilities at the FEMP are presently inactive in preparation for environmental restoration of the entire site.

Production activities at the FEMP ceased in 1989 and the mission is now site clean-up and remediation. In 1986, the DOE and United States Environmental Protection Agency (US EPA) entered into a Federal Facility Compliance Agreement (FFCA), which included provisions to remediate the FEMP pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The provisions of the 1986 FFCA relating to the Remedial Investigation/Feasibility (RI/FS) and remedial action were amended in 1990 with the signing of the Consent Agreement under CERCLA Section 120 and 106(a). In 1991, the DOE and US EPA amended the Consent Agreement to revise the remediation schedules and to add additional removal actions.

To aid in the remediation effort, the FEMP is divided into Operable Units (OUs). Operable Unit 1 is on the west-central boundary of the FEMP and includes Waste Pits 1 through 6, the Clearwell, and the Burn Pit (see Figure 2-1). The perched groundwater within the pit area is also within the scope of OU-1. Waste Pits 3 and 5 are referred to as "wet" because they received mostly waste in slurry form. Pits 1, 2, 4, and 6, are referred to as "dry" since they received mostly dry solid wastes from trucks. The following represents a brief overview of each waste pit. This information was compiled from the "Waste Pit Contents Study Report" (PARSONS 1993).

Waste Pit 1, constructed in 1952, contains neutralized waste filter cake, production plant sump cakes, depleted slag, scrap graphite, contaminated scrap, and sump liquor. Portions of the pit were lined with clay. In 1959, Waste Pit 1 was backfilled and covered with clean soil.

Waste Pit 2 contains neutralized waste filter cake, scrap graphite, contaminated brick, sump liquor, sump cake, depleted slag, concrete and construction rubble. Constructed in 1957, the pit is lined with compacted native clay. In 1964, the pit was taken out of service, backfilled, and covered with clean soil.

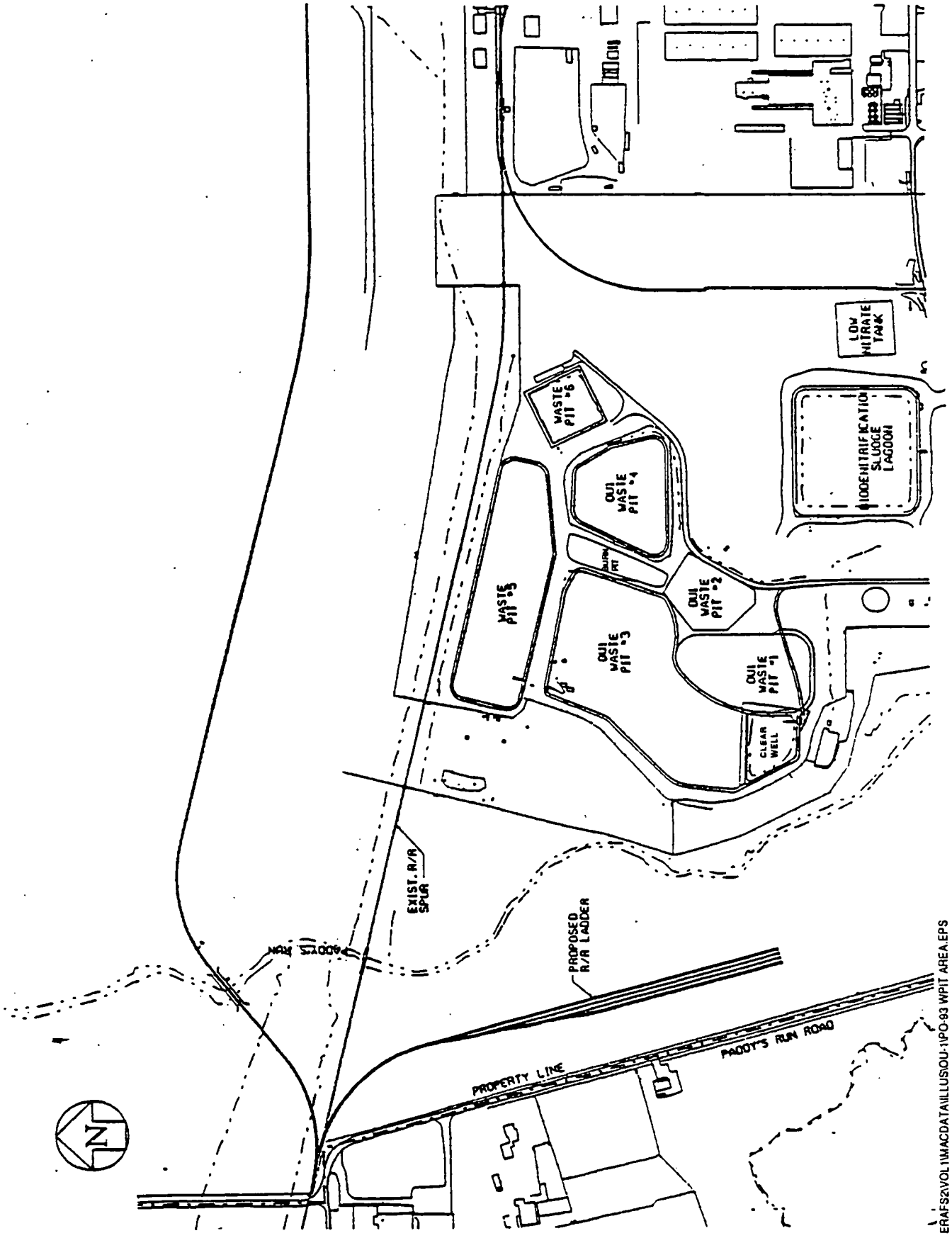


Figure 2-1 - OU-1 Waste Pit Area

Waste Pit 3, a clay-lined pit, was constructed in 1959 and removed from service as a wet pit in 1968. Subsequent use was limited to dry materials until 1977 at which point the pit was taken out of service, backfilled and covered with clean soil. The pit contains lime-neutralized raffinate, slurries from the Ore Refinery and Recovery Plant, fly ash, and wooden pallets.

Waste Pit 4 was constructed in 1960. It contains depleted uranium residues, low grade thorium residues, contaminated ceramics, general refuse, process residues, trailer cake, slurries, raffinates, graphite, noncombustible trash, asbestos, uranium metal, magnesium fluoride, concrete, and thorium. The pit has a clay liner approximately 2-feet thick. In 1986, the pit was covered with clean soil. An approved RCRA cap consisting of compacted bentonite clay cover overlain by a 45-mil-thick Hypalon liner was installed over the pit in 1988.

Waste Pit 5 was constructed in 1968 and is lined with an Ethylene Propylene Diene Monomer (EPDM) elastomeric membrane. The pit contains solids from neutralized raffinate settled solids, slag leach slurry, sump slurries, and lime sludge. The use of the pit as a settling basin ceased in 1987.

Waste Pit 6 received green salt (uranium tetrafluoride), filter cake, fine depleted slag, and process residues. The pit, which was constructed in 1979, is lined with an EPDM elastomeric membrane. The pit was removed from service in 1985 but remains open.

The Burn Pit, constructed in 1957, was used to dispose of and burn laboratory chemicals, including pyrophoric and reactive chemicals. In addition, waste oils and other low-level contaminated combustible materials were also burned in this pit. The northern end of the Burn Pit was backfilled in 1968 during the construction of Waste Pit 5. It is now overgrown with grass.

The Clearwell was constructed in 1959. It currently receives surface water runoff from the pits and liquid from Waste Pit 5. The Clearwell was used as a final settling basin before water was discharged into the Great Miami River.

SECTION 3

REQUIREMENTS FOR WASTE TRANSPORTATION AND DISPOSAL

One of the remedial alternatives currently under consideration by FERMCO for OU-1 includes off-site disposal. If off-site disposal remains a viable alternative, then transportation of OU-1 waste to an off-site disposal location must be addressed. This section identifies the requirements for transportation and off-site disposal requirements for OU-1 waste.

As required by the Amended Consent Agreement, Section XIII, permits must be obtained for any off-site activity. The DOE must notify the US EPA in writing of all permits required for off-site activities as soon as practicable after the DOE becomes aware of the requirement. Upon request of the US EPA, the DOE is to provide copies of all such permit applications and other documents related to the permitting process. As noted in Section 3.1, transportation permits may be required for LSA shipments in some transit states.

In addition to the permitting requirements, the Amended Consent Agreement requires that all materials removed from the site shall be disposed of or treated at a facility operating in compliance with the US EPA's Off-Site Policy (Revised Procedures for Planning and Implementing Off-Site Response Actions-Interim Policy, from J. Winton Porter dated November 13, 1987). Although this requirement is identified in Section IX of the Consent Agreement, Removal Actions, it is envisioned that this would apply to all materials being offered for disposition or treatment. The purpose of the off-site policy is to avoid having CERCLA wastes contribute to the present and future environmental problems by directing wastes to facilities determined to be environmentally sound. In general, the following listed conditions must be met in order to use an off-site receiving facility:

1) The proposed receiving facility must be operated in compliance with all applicable Federal, State and local regulations; there must be no relevant violations at or affecting the receiving facility.

2) There must be no releases from the receiving unit and contamination from prior releases at the receiving facility must be addressed, as appropriate.

A program to implement the requirements of the off-site policy has been established for the FEMP. These procedures will need to be followed for any CERCLA waste material shipped off site.

3.1 Applicable or Relevant and Appropriate Requirements

ARARs address substantive environmental requirements, clean-up standards, and standards of control. ARARs are used in the development of Comprehensive Environmental Response Compensation Liability Act (CERCLA) response actions to define levels of protection for human health and the environment. Appendix A contains a list of the ARARs for transportation of OU-1 wastes.

Non-regulatory guidance documents and proposed regulations termed "To Be Considered" (TBC) will also be met to the extent possible. The incorporation of TBC's will be determined by the DOE/FERMCO.

Although transportation requirements may not officially qualify as ARARs (although they are still required to be met), a review of the transportation regulatory framework discussion in *Identification of Transport and Waste Acceptance Criteria*, dated December 1992, was conducted. Federal DOT transportation regulations are included in the ARAR list as are state transportation regulations.

The US EPA and Ohio EPA regulations do not apply to LSA (or other radioactive) materials and were omitted from the ARAR Table in Appendix A. LSA is a low-level radioactive waste (LLRW), but LLRW is not an LSA waste. By definition, LSA material is a transportation classification (49 CFR 173). The LLRW classification is for disposal (10 CFR 71). Many of the DOT regulations which may not apply to the transportation of LSA material have been highlighted in bold and underlined in the ARAR list. Reference Subsection 3.3 for additional discussions pertaining to LSA and LLRW.

Table A-3 was provided by others and the state regulations cited there were not available for review. Therefore, it was assumed that they all apply to LSA material transportation and contain the provisions attributed to them in the "comment" column of the list. It should be noted, however, that from past legal research there appears to be some additional state regulations which are not included in the ARAR list.

A Transportation Legislative Data Base (TLDB) (Battelle 1989) identifies radioactive and hazardous materials transportation laws and regulations for the DOE nuclear waste repository office. According to the TLDB, there may be additional state regulations not contained in the ARAR list for the states of Colorado, Kansas, Illinois, Nevada, New Mexico, and Wyoming (see TLDB excerpt Appendix B). These additional regulations are in the areas of transportation permits, fees, and routing. For a further discussion, see Subsection 3.4. Depending on the disposal facility and shipment route chosen, some of the states listed in the ARAR list may not result in being transit states.

3.2 General Packaging and Shipping Requirements

The following presents an overview of packaging and shipping requirements the FEMP must comply with for transporting LSA material to any of the potential disposal facilities. Subsection 3.1 and Appendix A identify specific packaging, shipment, and regulatory requirements in greater detail.

1) For nonexclusive shipment, the external radiation levels for packages are limited to 200 mrem/hr at contact with package surfaces and a transportation index of 10 as defined in 49 CFR 173.403 (bb). The transportation index, a dimensionless number, is the radiation level at 1 meter from the surface of the container. For exclusive use shipments, the maximum package contact acceptable dose rate is 1,000 mrem/hr.

2) The DOT levels for loose radioactive contamination shall be adhered to and compliance must be documented.

3) The materials generated from the remediation of the waste pits will be either encapsulated in polyethylene, vitrified, or dry treated waste shipped in disposable or reusable containers, or as bulk material. Encapsulation or vitrification will stabilize the radioactive contaminants, as well as prevent any liquids from draining off the material. If the material is shipped as bulk to the NTS, it will be dried and placed into bags prior to being loaded into the DOT approved containers. The controls discussed above are designed to mitigate the potential for release of contamination in the event of an accident, as well as limit exposure levels.

4) Table 3-1 reflects the containers acceptable for disposal at each site.

Table 3-1 - Containers Acceptable for Disposal at Each Site

Sites	Containers		
	2 yd^3 (Truck Only)	15 yd^3	Gondola (Rail Only)
Portsmouth	Yes	Yes	Yes
NTS	Yes	Yes	No
Envirocare	No	No	Yes

5) The total number of containers per volume/density scenarios type is shown in Table 3-2.

Cost Analysis Data:

(1) Weight and volume constraints for different weight densities will determine the number of containers. To ensure against container over filling, volumes are calculated at 95 percent of containers capacity or usable volume as dictated by weight limitations.

(2) Maximum net weight of 2 yd^3 box is 7,700 lbs; weight of box is 700 lbs.

(3) Maximum gross weight of 15 yd^3 box is 42,000 lbs; tare weight is 5,000 lbs.

(4) Maximum net weight of gondola car is 160,000 lbs.

Table 3-2 - Number of Containers per Volume/Density Scenarios

Volume Scenario	Waste Volume	Waste Density (lbs/ft^3)	Number of Containers[a]		
			Gondola (166.25 yd^3) Weight Limit 160,000 lbs	2 yd^3 Box Weight Limit 8,000 lbs	15 yd^3 Box[b] Weight Limit 37,000 lbs
A	600,000 yd^3	100	11,000	316,000	47,000
B	1,000,000 yd^3	100	18,000	527,000	77,000
C	1,400,000 yd^3	100	25,000	737,000	108,000
A	600,000 yd^3	125	14,000	316,000	58,000
B	1,000,000 yd^3	125	23,000	527,000	97,000
C	1,400,000 yd^3	125	32,000	737,000	135,000
A	600,000 yd^3	180	N/A[c]	400,000	80,000
B	1,000,000 yd^3	180	N/A[c]	667,000	134,000
C	1,400,000 yd^3	180	N/A[c]	934,000	187,000

(a) Please note that in each instance the number of containers was rounded up to the nearest thousand.

(b) The 15 yd^3 container is used as a means for comparison. Actual container volume will be determined based on density of the material being shipped to maximize packaging of the container. The cost of the containers is assumed not to be impacted.

(c) It is not practical to consider loading and unloading glass blocks into a gondola car. Reference Subsection 4.5.3 for further detail.

6) Table 3-3 reflects the number of reusable containers per volume/density scenarios.

Table 3-3 - Number of Reusable Containers per Volume/Density Scenarios

Volume Scenario	Waste Volume	Waste Density (lbs/ft³)	Number of Containers[a]					
			15 yd³ Reusable Box Weight Limit 37,000 lbs Envirocare		15 yd³ Reusable Box Weight Limit 37,000 lbs NTS		15 yd³ Reusable Box Weight Limit 37,000 lbs Portsmouth	
			Truck	Rail	Truck	Rail	Truck	Rail
A	600,000 yd³	100	1,540	1,740	1,540	1,740	1,320	1,550
B	1,000,000 yd³	100	2,530	2,850	2,530	2,850	2,150	2,530
C	14,000,000 yd³	100	3,550	4,000	3,550	4,000	3,020	3,550
A	600,000 yd³	125	1,900	2,150	1,900	2,150	1,620	1,910
B	1,000,000 yd³	125	3,190	3,590	3,190	3,590	2,710	3,190
C	1,400,000 yd³	125	4,440	4,990	4,440	4,990	3,770	4,440
A	600,000 yd³	180	2,630	2,960	2,630	2,960	2,230	2,630
B	1,000,000 yd³	180	4,340	4,880	4,340	4,880	3,690	4,340
C	1,400,000 yd³	180	6,140	6,920	6,140	6,920	5,230	6,150

7) Table 3-4 reflects the containers per truck trailer or rail car.

Table 3-4 - Containers per Truck Trailer or Rail Car

Container Type	Truck	Rail
2 yd³	5 per dry van	N/A
15 yd³	1 per flatbed	3 per flat car

8) Reusable container assumptions applicable to Portsmouth:
   (1) 18 plastic disposal bags at $25 each equals $450 per 15 yd^3 container
   (2) Plastic disposal bags will be buried with waste
   (3) Reusable 15 yd^3 container (ISO) costs $7,000

9) Other transportation and box data:
   (1) 2 yd^3 container costs $700
   (2) Non-reusable 15 yd^3 container costs $3,500
   (3) 30 day round trip for rail to the NTS/Envirocare
   (4) 10 day round trip for truck to the NTS/Envirocare
   (5) 4 day round trip for rail to Portsmouth
   (6) 2 day round trip for truck to Portsmouth
   (7) Gondola liner costs $400.

10) Table 3-5 identifies transportation unit costs per trailer or rail car to each selected disposal site.

Table 3-5 - Transport Cost (Per Trailer or Rail Car Unless Otherwise Noted)

	NTS	Envirocare	Portsmouth
Truck Dry Van	$2,650/trailer	N/A	Prorated, based on mileage Fernald—NTS
Truck Flat Bed	$3,000/trailer		
Rail Box Car Flat **Plus** **Drayage Cost**	$1,850/Container Plus $400/Container	$1650/Container N/A	$500/Container N/A
Return Cost (reusable containers only)	$450/Container	N/A	$200/Container

3.3 Waste Acceptance Criteria

The United States Department of Transportation (DOT) has specific requirements for the handling, packaging, and transportation of LSA material (see discussion in Subsection 3.1). The disposal facility's waste acceptance criteria at each location either meet or exceed the DOT specified requirements. (Presently, there are no waste acceptance criteria established for Portsmouth, and therefore it is assumed that the acceptance criteria are the same as Envirocare).

LSA material can be shipped as either bulk or packaged material. As required under 49 Code of Federal Regulations (CFR) 173.425(c), unpackaged (bulk) shipments of LSA material shall be transported only in exclusive use closed transport vehicles (gondola railcars or dump trucks). Bulk packaging (as defined in 49 CFR 171.8) means a packaging, other than a vessel or a barge, including a transport vehicle or freight container, in which materials are loaded with no intermediate form of containment and has a maximum net weight greater than 400 kg (882 pounds). The shipment of LSA materials is within the confines of the LLRW regulations, but LLRW is not within the confines of the LSA regulations. LSA is a special case applied for transportation. Under these conditions, bulk rail hauling may not be a viable transport option if the waste is classified as a LLRW material. It will therefore be implied that the regulations for LSA materials will meet all LLRW requirements.

The failure to use appropriate DOT approved strong tight containers, may result in the materials being rejected at the disposal facility and returned to the consignee at the shipper's expense. Additionally, a breach of container integrity would result in the dispersion of radioactive materials. This action will result in additional decontamination and cleanup costs, which would be incurred by the shipper.

3.3.1 NTS Bulk Waste Shipment

Since no rail line is available to the NTS, the shipment of bulk treated waste can only be accomplished through the use of trucks, or combination of railcars and trucks. The waste can be transported by rail to Las Vegas, Nevada at which point the waste would be transferred onto trucks for shipment to the NTS. Bulk wastes being shipped to Area 3 of the NTS site must comply with the waste acceptance criteria for low level waste, as well as the above-noted criteria identified in 49 CFR 173.425(c). Bulk waste containers (i.e., 15 yd^3 or 2 yd^3) must be approved by DOE Nevada (DOE/NV). The bulk containers may be returned to the generator after decontamination. The decontamination and return of the bulk containers will incur additional operational costs for the generator. Truck trailers (if not purchased specifically for the shipment of radioactive materials) must meet the radiological free release levels identified in "NV 54XG.1A, DOE/NV Radiological Safety Manual, Off-Site Release Limits." Each time the trailer is decontaminated, it may generate additional LSA waste. This waste will result in additional disposal costs. At present, the NTS is not accepting any unpackaged (bulk) waste. Currently drums, boxes, and containers are off loaded and buried intact. As for the reuse of containers, this will have to be reviewed and approved by DOE/NV prior to shipment. The empty containers would be returned to the consignee in accordance with 49 CFR 173.427; "empty radioactive materials packaging."

Packaging specifications for the NTS (except for unpackaged bulk) require that the package will not be breached under normal handling conditions; packaged in drums or containers that will be capable of supporting a uniformly distributed load of 4,000 lbs per square foot; delivered in a manner in which it can easily be off-loaded; and the interior volume is as efficiently and compactly loaded as practical. Containers (2 yd^3) in excess of 9,000 pounds or drums that exceed 1,200 pounds require crane or forklift removal and must be approved by Reynolds Electrical & Engineering Company/Waste Management

Department (REECo/WMD) prior to shipment. Shipments of this type must be in a removable-top or removable-side trailer.

The use of polyethylene bags alone may not meet NTS acceptance criteria if the bags are filled with dried waste. The dried waste could have particulates which fail to meet the general waste acceptance criteria in Section 5 of the Nevada Test Site Defense Waste Acceptance Criteria, Certification, and Transfer Requirements (NVO-325, Revision 1) (DOE 1992). It may be practicable to overpack the bags with 6-mil plastic bags. This action should capture particulates which could pass though the woven bags, thus providing secondary containment. It will also have to be determined if these bags can support the 4,000 lbs per square foot strength requirement or if the bags can be stacked without toppling. This type of packaging would require prior approval before shipment. The option to ship reusable containers is not considered in this report.

3.3.2 Envirocare/Portsmouth

It is assumed the waste acceptance criteria for Portsmouth is comparable to that of Envirocare. All defined criteria within this section will therefore apply to Portsmouth, as well as Envirocare.

As a result of the Envirocare Radioactive Waste License and Hazardous Waste Permit, the Envirocare facility can accept LSA materials and/or many solid-phased mixed wastes including:

1) Dried process sludges
2) Solid process wastes
3) CERCLA response action wastes
4) Natural Occurring Radioactive Material (NORM)
5) Mixed wastes from industrial processes
6) Treatment residues

Envirocare's facility has access from both the interstate highway and the railroad. Waste materials for disposal may be packaged in any of a number of container types or bulk shipment methods including the following:

1) Bulk transport-gondola railcars
2) Bulk transport-intermodal containers
3) Bulk transport-dump trucks
4) Metal box containers in various sizes
5) Metal drums
6) Polyethylene bags

Pre-samples of materials which represent the bulk waste must be tested for moisture content prior to shipment. The bulk materials should be within the prescribed range identified in the waste acceptance criteria. This will allow for maximum compaction of the bulk waste. Materials with free standing water will not be accepted. Envirocare accepts gondola car shipments of unpackaged waste. During adverse weather conditions, the gondola cars cannot be rolled over; therefore, the Envirocare and Portsmouth facilities will utilize special equipment to empty the treated waste material out of the rail cars. The rail car will be rolled over at the proper location. As a result of the large volume of waste, the cost of the external decontamination of containers returned to the generating facility will be identified as a disposal cost. At present, Envirocare is sealing up and decontaminating external surfaces of bulk transport containers for return to the generator. Envirocare and Portsmouth have the necessary rail spurs to accommodate rail shipments.

3.4 State Issues

The principal state issues surrounding low-level radioactive waste transportation concern routing, permits, and fees. All three issues are regulatory based. As the ARAR list and Subsection 3.1 suggest, among the states named in the provided ARAR List, state routing requirements appear to exist in Colorado, Kansas, New Mexico and Wyoming. Transport permit requirements appear to exist in Colorado, Illinois and Wyoming (highway) and Nevada (rail). Transport fees are part of the Colorado and Nevada permit requirements and are required separately in Missouri. As the excerpts from the TLDB further show (Appendix B), there are other state regulatory issues, such as insurance, incident notification, and inspections, but they are not considered as widespread or as restrictive as the three issues identified.

SECTION 4

TRANSPORTATION ANALYSIS

This section discusses the transportation options and selection criteria for transporting the treated OU-1 waste to an off-site disposal site. The transport and disposal site selection criteria include many variables such as risk, cost, regulations, highway and rail infrastructure, etc. These issues, with the exception of regulations, are factored into routing data bases (Subsection 4.4) and are addressed in this section, whereas regulatory requirements are discussed in Section 3.1.

4.1 Goals and Objectives

The objective of this section is to provide a risk assessment on competing routes for truck and rail to the three disposal sites and to estimate transportation costs for each route/disposal site combination.

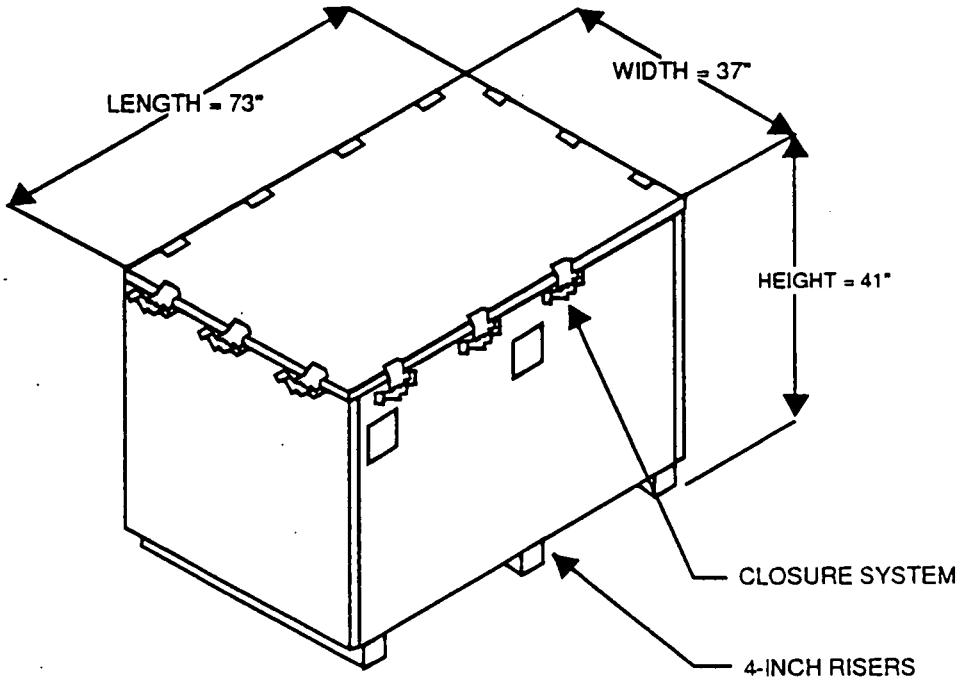
4.2 Alternatives

The movement of FEMP LSA waste to an off-site final disposal area can be accomplished by two transportation modes: truck and rail. Within each of the two modes are several shipment options as shown. These options relate to the packaging of the LSA waste for logistical and operational purposes. Figures 4-1 and 4-2 depict an isometric sketch of the 2 yd^3 and 15 yd^3 container, respectively. These containers can be transported on/in flatbed (truck) trailers, standard (rail) box cars, etc. The use of containers is the preferred shipment option for NTS based on current waste acceptance criteria for the facility. Figure 4-3 is a side view of the gondola rail car. This rail car option is designated for the shipment of bulk (unpackaged) LSA waste. The gondola car is the preferred transportation mode for shipment of bulk to Envirocare. The cost presented in the cost tables (see Tables 4-5 through 4-10) is based on the unpackaged materials option of using a gondola car.

1) Truck
   - (1) Container in dry van trailer
   - (2) Container on flat bed trailer

2) Rail
   - (1) Containers on:
     - a) Flat car
   - (2) Containers in:
     - a) Depressed center flat car
     - b) Intermodal double stack car
     - c) Standard box car

LSA 2-Cubic-Yard Waste Container for the Storage and Shipping of LSA Materials



Note: All dimensions are approximate

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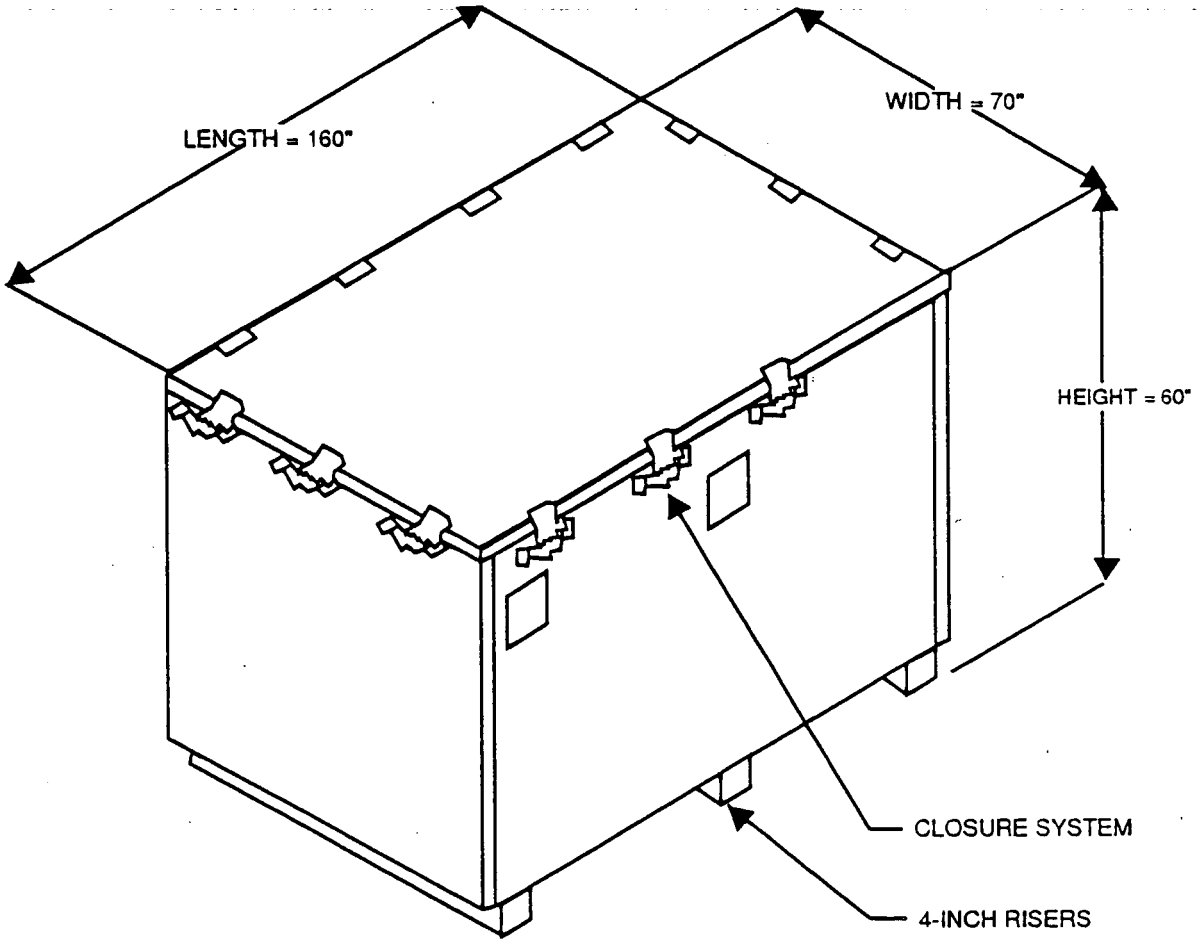
Figure 4-1 - 2 yd^3 Container

LSA 15-Cubic-Yard Waste Container for the Storage and Shipping of LSA Materials



Note: All dimensions are approximate

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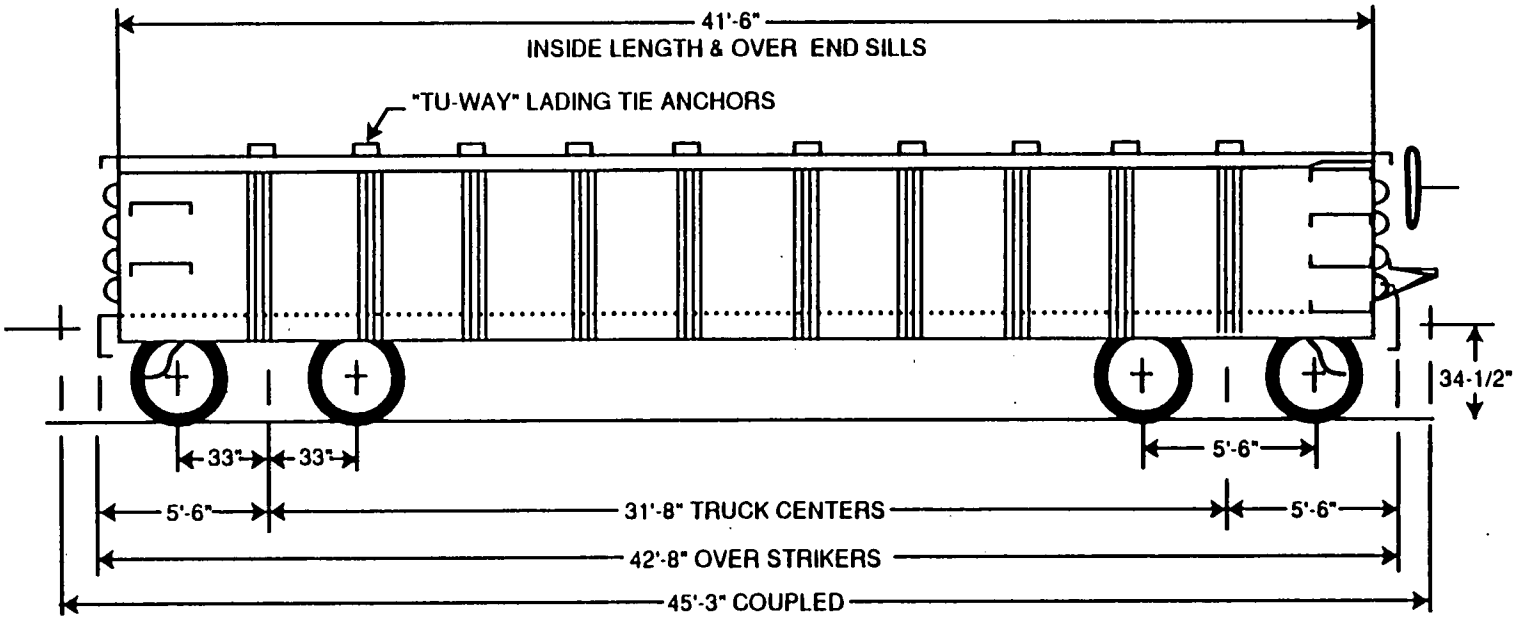
Figure 4-2 - 15 yd^3 Container

920000

Gondola Rail Car



Note: All dimensions are approximate

Maximum gross weight
is approximately 200,000 pounds

FS2\VOL1\MACDATA\ILLUS\OU-1\PO-93\RAIL GONDOLA.EPS

ERAFS1\VOL1:RSAPPS\RSDATA

Figure 4-3 - Gondola Rail Car

d) Special box car
e) Covered hopper car
f) Gondola car

4.2.1 Truck Transportation

The truck transportation mode uses tractor and semi-trailer (dry van and flatbed) trucks configured for unrestricted operation on the Interstate Highway System. The trip starts with a loaded trailer at the FEMP site with the loaded truck traveling to the final destination by public highway. The same tractor and drivers remain with the shipment from origin to destination. The routes will typically be selected to maximize travel on the Interstate Highway System and minimize risk. When appropriate, by-passes around cities will be used to reduce risk and to abide with state and local regulations.

Of the two modes (truck and rail) considered, truck transportation presents the most restrictive size and weight limits. Each truck will be limited to one 20-ton or four 5-ton boxes. Trucks are, however, able to provide the greatest flexibility of service and the shortest transportation time. Overall average truck speed is essentially independent of the distance traveled. Within the range of routes likely to be selected for these shipments, the truck speed will also be similar for eastern and western shipments.

4.2.2 Rail Transportation

Railroads are privately owned and operated. All railroad operations in the United States are for freight service except Amtrak (intercity passengers), commuter services (around major metropolitan areas), and tourist attractions. Most passenger railroads operate on right-of-ways owned by freight railroads (except for the Northeast Corridor).

In most cases, freight railroads do not share ownership of their trackage, and shippers and receivers are generally served by only one railroad. All railroads in the United States are interconnected which allows freight to be interchanged between railroads. The majority of freight movements require the use of two or more railroads between origin and destination.

Railroads are generally very reluctant to use non-standard operating practices or vehicles even when they are able to. For example, operating shorter than standard trains diminishes efficiency and raises operating costs while hauling over-size or over-weight cars often requires circuitous routing or causes scheduling interference with other trains. At the same time, railroads have shown a willingness to adapt their operating practices for long-term or high-volume market opportunities. The development of unit trains (100 or more cars hauling a single commodity such as coal from a single origin to a single destination) and intermodal shipments (hauling highway trailers on flat cars) are examples.

The rail system is able to carry larger and heavier loads than the truck system. One rail car can carry three 20-ton boxes. Large numbers of rail cars (50 to 100) can travel together in one shipment. The overall speed for rail transportation depends on the distance traveled. Due to the longer travel distances between yards, overall average travel speed for rail is typically greater west of the Mississippi River. In addition, the rail route is typically longer than the truck route by about 10 to 20 percent.

Rail service is not available to the NTS. Truck drayage will be used on the final part of the journey from Las Vegas to the NTS. The Portsmouth facility has a rail spur that connects to the main rail line that runs between Portsmouth and Columbus, Ohio. The spur enters the North West corner of the site; therefore, no drayage would be required at Portsmouth.

4.3 Selection Criteria

Based upon the population density, distance traveled, and accident rates for particular stretches of highways or railways, the risk associated with a particular transportation route can be developed. Through the use of the RADTRAN 4 computer code, the risk associated with the transportation of radioactive material over each of the chosen routes can be calculated.

RADTRAN 4 evaluates the radiological consequences of incident-free transportation as well as the risks from vehicular accidents occurring during transportation. Sandia National Laboratories developed the original RADTRAN code in conjunction with the development of NUREG-0170, "Final Environmental Impact Statement on the Transportation of Radioactive Material by Air and Other Modes."

For the purposes of this study, both primary and secondary highway and railway routes were designated for each of the three destinations. A secondary route was declared so that a comparison of risk could be provided for the different modes and transportation routes. The approach to determine the primary and secondary routes are explained in further detail in Subsection 4.4.

For each of the three sites, it was assumed that reusable packages that contained dried wastes were shipped via both rail and highway. In addition, the risk associated with shipments of vitrified radioactive waste; radioactive waste encapsulated in polyethylene; and bulk shipments of dried wastes were calculated for the Nevada Test Site. A comparison between the risk associated with the shipment of packaged, treated waste and the other waste forms was completed and risk factors were developed. The risk factors are assumed to be the same for the Portsmouth and Envirocare facilities.

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4.4 Risk Assessment Evaluation

Transportation routes were developed for three separate destinations--Portsmouth, Ohio; Envirocare (Clive, Utah); and the Nevada Test Site (Mercury, Nevada)--for this study. The primary and secondary routes chosen were based upon the use of the HIGHWAY 3.1, INTERLINE 5.0, and INTERSTAT computer codes. HIGHWAY 3.1 and INTERSTAT were utilized for the highway transportation routes, while INTERLINE 5.0 was utilized for the railroad routing.

The HIGHWAY 3.1 program utilized the chosen input parameters--including the preference for interstate travel, two-person driving team, absence of penalty on the use of toll roads, avoidance of ferry crossings, avoidance of roads prohibiting truck use, average speed of 65 mph, commercial shipment, etc.--to determine the different routings. A minimum of four routes were generated from Fernald to each of the three disposal facilities. The first route generated by HIGHWAY 3.1 is generally the more straightforward and logical route. Alternative routings are typically generated in descending order of viability and logic. The four routes were then reviewed for duplication and viability. For instance, if two of the HIGHWAY 3.1 routes were exact duplicates with the exception of one small stretch of highway, one of the routes would be dropped from consideration. After this review process was completed, engineering judgement was used to determine the primary and secondary routes. This same philosophy was used for the review of the INTERLINE 5.0 railroad data as well. This philosophy associated with the choice of the primary and secondary routes was followed in all instances, with the exception of the NTS. Primary transportation routes (currently utilized or determined routings) were provided by FERMCO for the NTS. Please refer to Table 4-1 for details concerning the chosen primary and secondary route selections.

The HIGHWAY 3.1 database is essentially a computerized road atlas that currently describes 240,000 miles of highways, as well as the locations of major nuclear facilities. Several different types of routes may be calculated, depending on the set of user-supplied constraints. INTERSTAT was developed at Sandia Laboratories to find the optimal routes on the Interstate Highway System. Optimization is based on user defined weights of distance, population, and/or truck accident rate. Parameters utilized in the computer calculations allowed the operator to vary the requirements associated with distance traveled, accident rate and population density. INTERLINE was developed at the Oak Ridge National Laboratory to find likely routes for shipments over the U.S. railroad system. It uses a shortest-path algorithm that has been modified both to reflect the nature of railroad company operations and to accommodate a large transportation network.

The output from these programs (HIGHWAY 3.1, INTERSTAT, and INTERLINE) provided a portion of the input for the RADTRAN 4 program. As discussed in Subsection 4.3, the RADTRAN 4 program was utilized to calculate the risk associated with the different scenarios. The additional inputs required by the RADTRAN 4 program included isotopic data (Weston Report), number of shipments required for

one million cubic yards of treated waste material for the three designated densities, population densities, percent of overall travel time for different types of areas (rural, urban, suburban), dose rates, method of shipment, number of packages, etc. Due to the nature of this report, in all instances, the most conservative values possible were utilized as input into the different computer programs.

Three logical statements of fact form the basis for the RADTRAN 4 calculations:

1) The more miles that are traveled, the higher the likelihood of an accident - either rail or highway.

2) Accidents related to the drivers of other vehicles are more likely to occur in populated versus rural areas.

3) The postulated person-rem (sum of the dose equivalents of all individuals in an exposed population) from an accident scenario is greatest for an urban area, followed by suburban and the rural. The reason for this is the differing population densities for these three types of areas.

Table 4-1 - Computer Model Route Selections

Destination	Mode	Designation	Route	Miles
Envirocare, UT	Rail	Primary	CSXT[1]: Fernald, OH to Hamilton, OH to Dayton, OH to Lima, OH to Gary, IN to Chicago, IL; CNW[3]: Chicago, IL to Cedar Rapids, IA to Fremont, NE; UP[4]: Fremont, NE to Cheyenne, WY to Ogden, UT to Salt Lake City, UT to Clive, UT	1937
Envirocare, UT	Rail	Secondary	CSXT[1]: Fernald, OH to Hamilton, OH to Cincinnati, OH to East St. Louis, IL; TRRA[5]: East St. Louis, IL to St. Louis, MO; UP[4]: St: Louis, MO to Kansas City, MO to Kansas City, KS to Lawrence, KS to Cheyenne, WY to Ogden, UT to Salt Lake City, UT to Clive, UT	1913
NTS, NV	Highway	Primary	US 27, I-275, I-75, I-71/75, I-71, I-64, I-57/64, I-64, I-55/70, I-55, I-44, I-35/44, I-44, I-40, US 93, US 93/95, US 95, Local	2065
NTS, NV	Highway	Secondary	US 27, I-275, I-275/74, I-74, I-465/74, I-70, I-57/70, I-70, I-270, I-70, I-35/70, I-29/70, I/70, I-15, US 95, US 95 (Business), US-95, Local	1999
NTS, NV[6]	Rail/Highway	Primary	**RAIL:** CSXT[1]: Fernald, OH to Hamilton, OH to Cincinnati, OH to East St. Louis, IL; TRRA[5]: East St. Louis, IL to St. Louis, MO; UP[4]: St. Louis, MO to Kansas City, MO to Kansas City, KS to Lawrence, KS to Cheyenne, WY to Ogden, UT to Salt Lake City, UT to Provo, UT to Las Vegas, NV **HIGHWAY:** US 95, US 95 (Business), US-95, Local	2303 (Rail) 65 (Highway)
NTS, NV[6]	Rail/Highway	Secondary	**RAIL:** CSXT[1]: Fernald, OH to Hamilton, OH to Dayton, OH to Lima, OH to Gary, IN to Chicago, IL; CNW[3]: Chicago, IL to Cedar Rapids, IA to Fremont, NE; UP[4]: Fremont, NE to Cheyenne, WY to Ogden, UT to Salt Lake City, UT to Las Vegas, NV **HIGHWAY:** US 95, US 95 (Business), US-95, Local	2307 (Rail) 65 (Highway)
Portsmouth, OH	Highway	Primary	US 27, I-275, S 32, US 23	113
Portsmouth, OH	Highway	Secondary	US 27, I-275, I-71, US 35, US 23/35, US 23	142
Portsmouth, OH	Rail	Primary	CSXT[1]: Fernald, OH to Hamilton, OH to Ivorydale, OH; NS[2]: Ivorydale, OH to Portsmouth, OH	186
Portsmouth, OH	Rail	Secondary	CSXT[1]: Fernald, OH to Hamilton, OH to Ivorydale, OH to Cincinnati, OH to Covington, KY to Newport, KY to Siloam, KY to Portsmouth, OH	208

000031

(1) CSXT CSX Transportation
(2) NS Norfolk Southern
(3) CNW Chicago and North Western
(4) UP Union Pacific
(5) TRRA Terminal Railroad Association of St. Louis
(6) As rail service is not available to the NTS, all rail shipments to this destination will be off-loaded in Las Vegas and transported via highway to the NTS.

6325

It was determined during the course of this study that the lowest risk transportation alternative was the highway transportation of waste to the Portsmouth, Ohio facility. Conversely, the overall highest transportation risk was associated with the rail shipment of radioactive material to the Nevada Test Site (see Table 4-2).

Table 4-2 - Transportation Accident Risks (Person-rem) per Shipment

Mode	Destination	Rural	Suburban	Urban	Total	Relative Risk
Rail	Envirocare (Primary)	3.60E-4	1.15E-3	1.93E-3	3.44E-3	13
Rail	Envirocare (Secondary)	3.80E-4	8.21E-4	9.95E-4	2.20E-3	9
Highway	NTS (Primary)	3.91E-4	1.15E-3	1.33E-3	2.87E-3	11
Highway	NTS (Secondary)	3.84E-4	1.09E-3	8.26E-4	2.30E-3	9
Rail	NTS (Primary)	4.58E-4	9.78E-4	1.14E-3	2.58E-3	10
Rail	NTS (Secondary)	4.39E-4	1.21E-3	2.03E-3	3.68E-3	14
Highway	Portsmouth (Primary)	1.50E-5	2.11E-4	2.88E-5	2.55E-4	1
Highway	Portsmouth (Secondary)	2.05E-5	2.32E-4	1.92E-5	2.72E-4	1
Rail	Portsmouth (Primary)	2.75E-5	2.40E-4	2.14E-4	4.82E-4	2
Rail	Portsmouth (Secondary)	3.25E-5	2.37E-4	2.16E-4	4.86E-4	2

The risk factors per kilometer (km) for transport by both rail and highway are provided below:

Mode	Rural	Suburban	Urban
Rail	1.402E-7	2.681E-6	1.599E-5
Highway	1.370E-7	3.00E-6	1.600E-5

Note: 1 km equals approximately 0.6 miles.

These factors are based on the radiological accident risk per kilometer associated with the transfer of one shipment of dried or polyencapsulated CRU-1 waste material from Fernald to the NTS. Since the same material is being transferred to all three disposal sites, these unit risk factors are useful in analyzing the route/disposal alternatives. RADTRAN 4 determines the risk factors based on the product of frequency

and consequence (frequency - number of accidents per shipment, consequence - population dose [person-rem] due to accident).

The unit risk factors (risk/km) determined using RADTRAN 4 are multiplied by the distance in kilometers to the disposal locations to determine the occupational and public risk per shipment (Table 4-2). The relative risk is used as a comparison of the risk associated with each mode/route. For instance, the risk associated with shipment by rail to the NTS (secondary route) is at 14 times greater risk than shipment by highway to Portsmouth.

RADTRAN 4 uses these accident rates multiplied by the distance in kilometers to the disposal locations to determine the occupational and public risk. From the analysis of the output from HIGHWAY 3.1, INTERLINE, and INTERSTAT, the fraction of travel in rural, suburban, and urban population zones is similar for both highway and rail transport to each disposal facility. In addition, the accident rates per kilometer associated with each mode of transport are similar. Based on these similarities and the additional miles required for shipment by rail, the risks associated with rail will exceed those of highway.

While no calculations were performed to determine the risk associated with the transfer of radioactive material from the rail cars to tractor trailers for highway shipment from Las Vegas to the NTS, this transfer will significantly increase the total risk for this option. Prior to the choice of joint rail/highway shipment of OU-1 waste to the NTS, additional calculations should be prepared to determine the extent of this additional risk and the viability of this transportation option.

4.5 Cost Evaluation

The cost evaluation includes costs to purchase the waste containers and transport the containers to the disposal sites. Off-site disposal costs are not included in this report. Procurement costs of locomotives, rail cars, trucks, truck trailers, etc. are not included. The costs to decontaminate the reusable containers, rail cars, truck trailers, and other equipment are also excluded.

4.5.1 Cost Evaluation Factors

Costs were prepared for six cases: three proposed disposal sites via two modes of transportation. The cost factors are:

Schedule and Shipment Volumes

The schedule and volume for the transportation and disposal will be derived from different volume scenarios for the amount of treated waste from OU-1. The risk assessment is based on the parameters of population, mileage, and the accident rate associated with the transportation of 1 million cubic yards

of LSA material. The cost analysis is developed using the mileage determined by the risk assessment (primary and secondary routes) to the three disposal locations for the three different waste volumes. The schedules and volumes are the same regardless of destination or mode, and costs are provided accordingly. Costs are based on 1993 dollars assuming a 10-year shipment period without escalation. However, these costs are sensitive to inflation and will have to be escalated in accordance with revised schedules.

Equipment Costs

The costs to purchase DOT strong tight containers are calculated based on unit costs in previously prepared documents and other sources, and the treated waste volumes. Within each mode, the equipment requirements and costs are the same for each destination. Trucks and trains require different liners to retain the processed waste, resulting in different equipment costs between the two transportation modes.

Transportation Costs

Costs are calculated based on FERMCO negotiated rates (Table 3-5) which reflect volume and consistency discounts. These costs were derived from several ongoing or proposed shipments of hazardous materials from Fernald and other sites similar to the FEMP program. Transportation costs for trains include the cost to marshall inbound and outbound rail cars to deliver those cars to the appropriate loading facility. State transportation fees, permits, inspections, and insurances are not costed in this report. Note the shipment of 1 million yd^3 of waste far exceeds current volumes being shipped, and could result in lower costs based on economies of scale.

Total Costs

This cost analysis reflects costs incurred from loading the rail or truck at the FEMP to delivery of the waste to the gate of the disposal site. The total cost to purchase containers and liners, and shipment of the waste to the disposal site are calculated using the following formula. Disposal and handling costs are excluded from this analysis. However, handling (e.g., trailer, rail car loading) costs at the FEMP are included. Operations are based on 250 work days per year (50 weeks, 5 days per week).

000034

4.5.2 Operating Parameters

The proposed shipment schedule for truck and rail shipments is provided in Tables 4-3 and 4-4.

Table 4-3 - Number of Rail Shipments per Volume/Density Scenarios

Volume Scenario	Waste Volume	Waste Density (lbs/ft³)	Number of Shipments	
			Gondola (166.25 yd³) Weight Limit 160,000 lbs	15 yd³ Box Weight Limit 37,000 lbs
A	600,000 yd³	100	11,000	15,667
B	1,000,000 yd³	100	18,000	25,667
C	1,400,000 yd³	100	25,000	36,000
A	600,000 yd³	125	14,000	19,333
B	1,000,000 yd³	125	23,000	32,333
C	1,400,000 yd³	125	32,000	45,000
A	600,000 yd³	180	N/A	26,667
B	1,000,000 yd³	180	N/A	44,667
C	1,400,000 yd³	180	N/A	62,333

Table 4-4 - Number of Truck Shipments per Volume/Density Scenarios

Volume Scenario	Waste Volume	Waste Density (lbs/ft³)	Number of Shipments	
			2 yd³ Box Weight Limit 8,000 lbs	15 yd³ Box Weight Limit 37,000 lbs
A	600,000 yd³	100	63,200	47,000
B	1,000,000 yd³	100	105,400	77,000
C	1,400,000 yd³	100	147,400	108,000
A	600,000 yd³	125	63,200	58,000
B	1,000,000 yd³	125	105,400	97,000
C	1,400,000 yd³	125	147,400	135,000
A	60,000 yd³	180	80,000	80,000
B	1,000,000 yd³	180	133,400	134,000
C	1,400,000 yd³	180	186,800	187,000

4.5.3 Cost Analysis

The total costs for the cost analysis are based on the equipment costs and the transportation costs. The costs do not include handling, infrastructure improvements, decontamination, or disposal costs.

Tables 4-5, 4-6, 4-7, 4-8, 4-9, and 4-10 illustrate the total transportation cost in 1993 dollars to ship waste from the FEMP for volumes for truck and rail for a period of 10 years. Based on the maximum volume of 1.4 million cubic yards, the excavation rate would be approximately 600 yd^3 per day. As noted in Subsection 1.4, the excavated waste material may swell to approximately 12 percent over the in situ volume. This additional factor will need to be considered before any reduction in schedule can be assumed. An increase in this excavation rate could possibly decrease the overall off-site transportation costs by reducing the 10-year duration. The cost tabulations are based on the waste form densities established in Subsection 1.4. The elements included in these scenarios are:

1) Three disposal sites (NTS, Portsmouth, and Envirocare)
2) Two routes (primary and secondary)
3) Four waste containers (2 yd^3, 15 yd^3, 15 yd^3 reusable, and rail gondola)
4) Two modes (truck and rail)
5) Three waste volumes (600,000 , 1,000,000 and 1,400,000 yds^3)

There are some exceptions to these cost scenarios. Since there is no rail spur going directly to NTS, it would not be practical to consider rail (gondola) hauling of loose material to the facility because of the drayage requirements. As noted, the option to ship reusable 15 yd^3 containers is excluded based on current waste acceptance criteria at the NTS. The 2 yd^3 container is not a package accepted by rail companies and is therefore excluded from the rail cost analysis for all waste form densities. The rail gondola transportation option for the 180 lbs/ft^3 waste form density is not costed because it is assumed that this form is comparable to a solid glass block (see Subsection 1.4). In this case, the shape of the proposed gondola car would not allow the block to fit properly into the car. There is also the complexity of loading and unloading the blocks both on site and off site. For these reasons, this option is not costed. For truck transportation, there are some safety issues pertaining to the shipment of 180 lb/ft^3 material. Under the 15 yd^3 container option, it is calculated that five 1.5 yd^3 blocks can fit into a 15 yd^3 container without exceeding the weight limit. Considering the weight of the container and its contents, the load may shift and become unstable during transport, and impose a danger to other motorists. This option was costed nonetheless, but it should be noted that anchors and other provisions will be necessary to stabilize this load during transport. In addition, special handling devices will need to be attached to the blocks for loading and unloading. The costs for these items for the 180 lbs/ft^3 scenario are excluded. The shipment of treated waste off site may not be cost effective considering treatment and transportation costs will be incurred.

When comparing the various scenarios, disposal costs and FEMP and off-site infrastructure improvements are not included in the cost estimates. These costs could impact the final cost results for the shipping of treated waste to its final off-site disposal.

Table 4-5. TOTAL RAIL TRANSPORTATION COSTS OVER 10 YEARS

(Millions of Dollars in 1993, based on Waste Density of 100 lbs/ft^3)

Routes	Volume	Containers	NTS	Envirocare	Portsmouth
Primary Distance (miles)	A (600,000 YD^3)	2 YD^3	N/A	N/A	N/A
		15 YD^3	$279	N/A	$209
		15 YD^3 R	N/A	N/A	65
		Gondola	N/A	$58	13
	B (1,000,000 YD^3)	2 YD^3	N/A	N/A	N/A
		15 YD^3	457	N/A	343
		15 YD^3 R	N/A	N/A	107
		Gondola	N/A	94	21
	C (1,400,000 YD^3)	2 YD^3	N/A	N/A	N/A
		15 YD^3	641	N/A	481
		15 YD^3 R	N/A	N/A	149
		Gondola	N/A	131	29
Secondary Distance (miles)	A (600,000 YD^3)	2 YD^3	N/A	N/A	N/A
		15 YD^3	279	N/A	209
		15 YD^3 R	N/A	N/A	65
		Gondola	N/A	57	14
	B (1,000,000 YD^3)	2 YD^3	N/A	N/A	N/A
		15 YD^3	457	N/A	343
		15 YD^3 R	N/A	N/A	107
		Gondola	N/A	93	23
	C (1,400,000 YD^3)	2 YD^3	N/A	N/A	N/A
		15 YD^3	641	N/A	481
		15 YD^3 R	N/A	N/A	149
		Gondola	N/A	130	31

Notes:

	Mileage	NTS	Envirocare	Portsmouth
(1)	Primary	2062	1731	110
	Secondary	2005	1934	132

(2) Shipping volume is over 10 years.

(3) R indicates a reusable container.

9/7/93

Table 4-6. TOTAL TRUCK TRANSPORTATION COSTS OVER 10 YEARS

(Millions of Dollars in 1993, based on Waste Density of 100 lbs/ft^3)

Routes	Volume	Containers	NTS	Envirocare	Portsmouth
Primary Distance (miles)	A (600,000 YD^3)	2 YD^3	$389	N/A	$222
		15 YD^3	327	N/A	193
		15 YD^3 R	N/A	N/A	38
		Gondola	N/A	N/A	N/A
	B (1,000,000 YD^3)	2 YD^3	648	N/A	370
		15 YD^3	535	N/A	316
		15 YD^3 R	N/A	N/A	62
		Gondola	N/A	N/A	N/A
	C (1,400,000 YD^3)	2 YD^3	907	N/A	518
		15 YD^3	751	N/A	444
		15 YD^3 R	N/A	N/A	87
		Gondola	N/A	N/A	N/A
Secondary Distance (miles)	A (600,000 YD^3)	2 YD^3	389	N/A	222
		15 YD^3	327	N/A	195
		15 YD^3 R	N/A	N/A	40
		Gondola	N/A	N/A	N/A
	B (1,000,000 YD^3)	2 YD^3	648	N/A	371
		15 YD^3	535	N/A	319
		15 YD^3 R	N/A	N/A	65
		Gondola	N/A	N/A	N/A
	C (1,400,000 YD^3)	2 YD^3	907	N/A	518
		15 YD^3	750	N/A	448
		15 YD^3 R	N/A	N/A	91
		Gondola	N/A	N/A	N/A

Notes:

Mileage	NTS	Envirocare	Portsmouth
(1) Primary	2062	1731	110
Secondary	2005	1934	132

(2) Shipping volume is over 10 years.

(3) R indicates a reusable container.

Table 4-7. TOTAL RAIL TRANSPORTATION COSTS OVER 10 YEARS

(Millions of Dollars in 1993, based on Waste Density of 125 lbs/ft^3)

Routes	Volume	Containers	NTS	Envirocare	Portsmouth
Primary Distance (miles)	A (600,000 YD^3)	2 YD^3	N/A	N/A	N/A
		15 YD^3	$344	N/A	$258
		15 YD^3 R	N/A	N/A	80
		Gondola	N/A	$74	16
	B (1,000,000 YD^3)	2 YD^3	N/A	N/A	N/A
		15 YD^3	576	N/A	432
		15 YD^3 R	N/A	N/A	134
		Gondola	N/A	121	26
	C (1,400,000 YD^3)	2 YD^3	N/A	N/A	N/A
		15 YD^3	801	N/A	601
		15 YD^3 R	N/A	N/A	187
		Gondola	N/A	168	37
Secondary Distance (miles)	A (600,000 YD^3)	2 YD^3	N/A	N/A	N/A
		15 YD^3	344	N/A	258
		15 YD^3 R	N/A	N/A	80
		Gondola	N/A	73	18
	B (1,000,000 YD^3)	2 YD^3	N/A	N/A	N/A
		15 YD^3	576	N/A	432
		15 YD^3 R	N/A	N/A	134
		Gondola	N/A	119	29
	C (1,400,000 YD^3)	2 YD^3	N/A	N/A	N/A
		15 YD^3	801	N/A	601
		15 YD^3 R	N/A	N/A	187
		Gondola	N/A	166	40

Notes:

	Mileage	NTS	Envirocare	Portsmouth
(1)	Primary	2062	1731	110
	Secondary	2005	1934	132

(2) Shipping volume is over 10 years.

(3) R indicates a reusable container.

Table 4-8. TOTAL TRUCK TRANSPORTATION COSTS OVER 10 YEARS

(Millions of Dollars in 1993, based on Waste Density of 125 lbs/ft^3)

Routes	Volume	Containers	NTS	Envirocare	Portsmouth
Primary Distance (miles)	A (600,000 YD^3)	2 YD^3	$389	N/A	$222
		15 YD^3	403	N/A	238
		15 YD^3 R	N/A	N/A	47
		Gondola	N/A	N/A	N/A
	B (1,000,000 YD^3)	2 YD^3	648	N/A	370
		15 YD^3	674	N/A	399
		15 YD^3 R	N/A	N/A	78
		Gondola	N/A	N/A	N/A
	C (1,400,000 YD^3)	2 YD^3	907	N/A	518
		15 YD^3	938	N/A	555
		15 YD^3 R	N/A	N/A	10.9
		Gondola	N/A	N/A	N/A
Secondary Distance (miles)	A (600,000 YD^3)	2 YD^3	389	N/A	222
		15 YD^3	403	N/A	241
		15 YD^3 R	N/A	N/A	49
		Gondola	N/A	N/A	N/A
	B (1,000,000 YD^3)	2 YD^3	648	N/A	371
		15 YD^3	674	N/A	402
		15 YD^3 R	N/A	N/A	82
		Gondola	N/A	N/A	N/A
	C (1,400,000 YD^3)	2 YD^3	907	N/A	518
		15 YD^3	938	N/A	560
		15 YD^3 R	N/A	N/A	114
		Gondola	N/A	N/A	N/A

Notes:

Mileage	NTS	Envirocare	Portsmouth
(1) Primary	2062	1731	110
Secondary	2005	1934	132

(2) Shipping volume is over 10 years.

(3) R indicates a reusable container.

Table 4-9. TOTAL RAIL TRANSPORTATION COSTS OVER 10 YEARS

(Millions of Dollars in 1993, based on Waste Density of 180 lbs/ft^3)

Routes	Volume	Containers	NTS	Envirocare	Portsmouth
Primary Distance (miles)	A (600,000 YD^3)	2 YD^3	N/A	N/A	N/A
		15 YD^3	**$439**	N/A	**$320**
		15 YD^3 R	N/A	N/A	**75**
		Gondola	N/A	N/A	N/A
	B (1,000,000 YD^3)	2 YD^3	N/A	N/A	N/A
		15 YD^3	**735**	N/A	**536**
		15 YD^3 R	N/A	N/A	**125**
		Gondola	N/A	N/A	N/A
	C (1,400,000 YD^3)	2 YD^3	N/A	N/A	N/A
		15 YD^3	**1026**	N/A	**749**
		15 YD^3 R	N/A	N/A	**175**
		Gondola	N/A	N/A	N/A
Secondary Distance (miles)	A (600,000 YD^3)	2 YD^3	N/A	N/A	N/A
		15 YD^3	**439**	N/A	**320**
		15 YD^3 R	N/A	N/A	**75**
		Gondola	N/A	N/A	N/A
	B (1,000,000 YD^3)	2 YD^3	N/A	N/A	N/A
		15 YD^3	**735**	N/A	**536**
		15 YD^3 R	N/A	N/A	**125**
		Gondola	N/A	N/A	N/A
	C (1,400,000 YD^3)	2 YD^3	N/A	N/A	N/A
		15 YD^3	**1026**	N/A	**749**
		15 YD^3 R	N/A	N/A	**175**
		Gondola	N/A	N/A	N/A

Notes:

	Mileage	NTS	Envirocare	Portsmouth
(1)	Primary	2062	1731	110
	Secondary	2005	1934	132

(2) Shipping volume is over 10 years.

(3) R indicates a reusable container.

Table 4-10. TOTAL TRUCK TRANSPORTATION COSTS OVER 10 YEARS

(Millions of Dollars in 1993, based on Waste Density of 180 lbs/ft^3)

Routes	Volume	Containers	NTS	Envirocare	Portsmouth
Primary Distance (miles)	A (600,000 YD^3)	2 YD^3	$492	N/A	$281
		15 YD^3	520	N/A	293
		15 YD^3 R	N/A	N/A	28
		Gondola	N/A	N/A	N/A
	B (1,000,000 YD^3)	2 YD^3	820	N/A	469
		15 YD^3	871	N/A	490
		15 YD^3 R	N/A	N/A	48
		Gondola	N/A	N/A	N/A
	C (1,400,000 YD^3)	2 YD^3	1149	N/A	656
		15 YD^3	1216	N/A	684
		15 YD^3 R	N/A	N/A	67
		Gondola	N/A	N/A	N/A
Secondary Distance (miles)	A (600,000 YD^3)	2 YD^3	492	N/A	281
		15 YD^3	520	N/A	296
		15 YD^3 R	N/A	N/A	31
		Gondola	N/A	N/A	N/A
	B (1,000,000 YD^3)	2 YD^3	820	N/A	469
		15 YD^3	871	N/A	495
		15 YD^3 R	N/A	N/A	53
		Gondola	N/A	N/A	N/A
	C (1,400,000 YD^3)	2 YD^3	1149	N/A	657
		15 YD^3	1216	N/A	691
		15 YD^3 R	N/A	N/A	74
		Gondola	N/A	N/A	N/A

Notes:

	Mileage	NTS	Envirocare	Portsmouth
(1)	Primary	2062	1731	110
	Secondary	2005	1934	132

(2) Shipping volume is over 10 years.

(3) R indicates a reusable container.

SECTION 5

LESSONS LEARNED AND FACTORS TO CONSIDER

Some organizations have shipped and continue to ship large quantities of waste materials to Envirocare and NTS. Some actual case histories are presented to demonstrate the feasibility and viability of shipping large volumes of radioactive wastes over long distances. These case histories reinforce and support the option for off-site shipment and disposal of FEMP waste. They are:

Company:	Envirocare
Client:	N/A
Site of Repository:	Clive, Utah
Contact:	Susan Rice, Marketing Department (801-532-1330)
Date:	August 20, 1993

Summary: Envirocare has recently accepted some 7 million cubic yards of waste from a Colorado site.

Ms. Rice provided some perspectives on shipping issues as seen by the receiver of waste. The comments are provided as follow:

1) They prefer to receive containerized waste in 55-gallon drums on pallets for ease of unloading. Containers are accepted but are not buried at Envirocare. Container contents are unloaded and the containers may be resold to prospective shippers at a cost discount.

2) They do not accept free-standing liquids. They ask shippers to put absorbent pads under drums to absorb any liquids.

3) They ask that rail cars have liners, and require hard-top containers on the cars. A major reason for this requirement is the prevention of rainwater mixing with the waste material in transit. (If a shipment containing liquids arrives, they must test the liquids to determine if the liquids are hazardous - and thus not acceptable at the site.)

4) Unloading bulk waste in the rain could result in placement delays since the contaminated precipitation could require testing.

5) They have the capability to handle unit trains with a gondola-car rollover facility. They request flat-bottom gondola cars.

6) They charge by the container for Sea/Land containers. This tends to lead to overloaded containers which causes problems in inspecting the contents of the containers.

7) Some shippers have treated materials in drums by drilling holes in drums, treating, and then plugging the drilled holes. The appearance of the drums has raised questions of leakage when the drums arrive at the acceptance site. It was recommended that only intact drums be used for shipment.

8) Some of their shippers have encountered a number of problems with the availability and adequacy of rail cars. She recommends working with the railroads well in advance of shipments, arranging for good-quality cars, and inspecting them on arrival.

9) They find polyethylene bags work well for soil, but have encountered problems with them tearing when used for material such as piping.

10) They prefer mixed waste to be containerized.

Company:	Babcock and Wilcox
Client:	DOE
Site:	Apollo, Pennsylvania
Contact:	Mr. Richard Kingsley (412-478-6195)
Date:	August 20, 1993

Summary: Babcock and Wilcox has removed approximately 1.2 million cu. yds. of material from the site. The removal is approximately 95 percent complete. Railroad gondola cars with plastic liners are used. As of December, some 250 cars had been transported, with peak rates of 3 cars/day.

Mr. Kingsley shared what he believed to be the two most important lessons learned on the project.

1) Remediation projects are about surprises. He believes it is absolutely essential to have a "first-class, world-class" project manager and project management system. The system used at Apollo was developed for the petroleum industry. Cost/status information is updated weekly. Books are closed on Saturday and reports are available on Wednesday. The project control system provides a mechanism to raise problems to management attention rapidly. He does not believe that a simple CSCSC system is adequate to deal with this type of program.

2) When dealing with soil, the best place to store it is where it is. It shouldn't be excavated until just before transport. There were heavy rains and snows at the site, and controlling runoff was a major problem.

Other items discussed were as follows:

1) Some Technetium 99 got into the soil via the weapons program. While the amount was within allowable limits at the site, the disposal site cannot accept Technetium. As of the interview, they are still in the process of trying to resolve how to handle this problem. In the meantime, the Technetium-contaminated soil cannot be shipped.

2) They set up a commercial civil engineering crusher with the intent of running all soil, blocks, etc. through it in preparation for shipment. A significant amount of tramp metal was found to be in the material, resulting in substantial damage to the crushing mill. They installed a "stationary Grizzly" in front of the crusher to deal with this problem.

3) They budgeted $65 million for the cleanup, and are now at about $71 million (about 95 percent done). He says this is regarded as outstanding performance, and attributes their success significantly to their project management techniques.

Company:	Sevenson
Client:	EPA/DOE
Site:	Montclair, New Jersey
Contact:	Mr. Jack Brueckl
Date:	August 20, 1993

Summary: The conversation with Mr. Brueckl was very brief. He is in the process of shipping some 20,000 cubic yards of radium-contaminated material to Envirocare. He stated that the scheduling of railcars is a major problem. Emphasis was on keeping the workforce busy. He also noted that no two sites are alike. Each has its own unique problems.

Company:	Battelle
Client:	DOE/Pantex
Site:	Amarillo, Texas
Contact:	V. Pasupathi (615-220-4019) (Oak Ridge)
Date:	August 23, 1993

Summary: Mr. Pasupathi supports Pantex's shipments of material to NTS. Material is shipped by truck in 7'x7'x4' boxes. Approximately 7 boxes per month are shipped. Transit time is approximately one day. No special handling techniques are used for this material. Certain materials are transported by charter air carrier.

Mr. Pasupathi emphasized the need to gain a detailed understanding of the waste acceptance criteria at the receiving site and to comply strictly with those criteria in preparing materials for shipment. He also noted that one must get an exemption from the 5820.2A rules to ship DOE waste to a non-DOE site.

Company: Battelle
Client: DOE
Site: Various
Contacts: Ronald Carlson, Cort Horton, John Niestlie, and Gary Scott
Date: August 25, 1993

Summary: Battelle is involved in a D&D program for the Battelle-Columbus Site. Battelle has been previously involved in similar activities, notably the cleanup of the Denver Radium Site. This cleanup involved the shipment of some 450,000 tons of material to Envirocare. Without exception, they were of the opinion that use of the Envirocare site will be much less expensive if the FEMP can get the necessary waivers to send the material there. They also suggested that, if all the materials do not meet Envirocare's acceptance criteria, the FEMP consider sending all the material possible to Envirocare with the remainder going to other sites as required. (This is the practice they follow in Battelle's D&D program.)

It is their understanding that the Corps of Engineers (COE) has a contract for the disposal of one million cubic yards of material at a price of approximately $8-$11 per cubic foot, and that the COE is looking for other government agencies to use up some of that capacity. They were uncertain as to the expiration date of that contract, but thought it might be in the 1995-1997 range.

They noted that Envirocare's acceptance criteria are under the control of the State of Utah and are not likely negotiable. Utah requires that a Utah-approved organization inspect and approve the shipping site before any shipments can be made. Utah also requires split sampling of material to be shipped to the site. Envirocare's license doesn't allow the firm to bury containers. Drums are emptied, then crushed and buried separately. Additional costs may be incurred if container size deviates from contract. It is not expected that Envirocare will

000047

run out of space in the near future. It was noted that Envirocare can't handle waste which is RCRA only.

There was some discussion of on-site processing prior to shipment. It was noted that such processing requires approval, and that the approval process can be lengthy and complex. (Size/volume reduction isn't regarded as treatment.) It was also noted that the Oak Ridge facility only processes material -- the material remains the property of its original owner.

Some details on the Denver Radium Site experience.

1) Chem Nuclear was hired to coordinate all transportation arrangements and contracts.

2) Approximately 450,000 tons of material were moved from Denver to Clive via rail. The material was largely soil and building materials, with some mixed waste. No pretreatment was done.

3) The site was messy, but relatively uniform. Much of the material was tailings or ore.

4) Rail was chosen as the means of transport through a solicitation and proposal evaluation process. Technical factors had greater weight (60 percent) in the proposal evaluation than did cost (40 percent).

5) Material was transported in regular gondola cars supplied by the railroad. Some cars were not of high quality. The contract between Chem Nuclear and the Union Pacific Railroad required that Chem Nuclear would repair the rail cars at their own expense before shipment.

6) Roughly 10 cars/day were shipped, with each car containing approximately 40 tons. Generally, 10 cars per day went to a rail yard for holding until some 30-40 cars were accumulated, then sent by regular train to Envirocare.

7) Cars were weighed at the rail yard to assure compliance with railroad weight criteria. Overloaded cars were returned to the site and offloaded with a front end loader.

8) No special equipment was used for handling the material. There was no pretreatment of material at the site.

9) One big expense was installing rail spurs to some of the locations on the site.

10) Total cost of the program was about $60 million, plus about $25 million for transport.

11) In winter, cars sometimes froze and could not be unloaded at Envirocare. A liner was used during winter months to solve this problem.

12) Scheduling/obtaining rail cars from the railroad was an ongoing problem. Holidays posed special problems in this regard.

13) Extensive use of project management techniques was deemed critical to the success of the program.

During the performance of this study and while reviewing other previous studies, it has revealed several lessons learned and points to consider in planning the off-site shipments of OU-1 treated waste material. They include:

1) Many organizations (labs, hospitals, nuclear generating stations, and research institutions) throughout the country are regularly shipping LSA waste to disposal sites. Although in many cases the volumes are small, this shows that shippers and carriers have been able to develop mutually acceptable shipping practices that serve their needs while satisfying all applicable Federal, State, and local regulations.

2) Weight limits imposed by railroads and State highway departments or trucks must be followed. LSA material does not receive any special consideration regulations from these organizations. Shippers will be expected to follow standard transportation practices. Shipments returned by railroads or stopped by State enforcement agencies for being overweight will incur high cost and time penalties and, in the case of trucks, will present extreme transload challenges (since States generally require an overweight load to be "split" right at the weigh station). In contrast, underweight containers and vehicles will require that more shipments be made, resulting in added costs. Scales should be installed near or under the loading stations at the FEMP to optimize both rail and truck loading by weight.

3) States and local governments are constantly changing their routing regulations, specification of approved routes and transportation fees for hazardous material shipments, including radiological materials. Shippers should continually monitor these changes.

4) Truck companies and railroads are willing to negotiate rates and service requirements for LSA shipments. Traditional tariff-based shipping agreements with preset price and service levels are probably not the most favorable approach for shippers of LSA materials. Contract agreements allow price, pickup times, delivery times, transit speed, special handling, tracking, and other value-added services to be arranged to best serve the shippers needs.

5) The various waste handling and shipping needs at the FEMP should be coordinated to create the strongest possible bargaining position. Potential carriers will be more interested in negotiating for the all of FEMP shipments rather than portions. This promotes efficiency for both the shipper and the carriers.

6) Potential carriers should be involved in the planning process to develop a cooperative environment. Carriers have extensive knowledge in the handling of hazardous and bulk materials and their expertise should be utilized. Preliminary shipping agreements should be established with carriers as soon as the FEMP's shipment schedules are known. This will preserve both the transportation options and the carrier interest and involvement.

7) For developing the risk assessment, the nearest rail line to NTS is about 65 miles away. The rail line is estimated to be 100 miles away in the cost analysis. The ability to ship by rail directly to the NTS site, rather than changing to truck transportation in Las Vegas, would lower costs and reduce public concern. Shipments from the FEMP, by themselves, would not justify building the connecting rail line; however, the civilian high-level waste program, Office of Civilian Radioactive Waste Management (OCRWM) is also considering a disposal site near the NTS and may consider building a rail line, particularly if other users can be identified. OCRWM should be contacted about any interest in using the NTS and constructing a connecting rail line.

8) During the planning of the FEMP waste shipment program, it should be determined if the disposal site is willing to accept the entirety of the LSA shipments. Changing sites after the shipment program begins will require coordination with additional states and renegotiations with the carriers.

9) An intense shipment schedule leaves little room for interruptions. Up-front investments should be made to ensure reliability of loading and transportation. These may include parallel loading tracks for rail shipments, spare containers and vehicles that are ready, at stand-by, and a rigorous preventive maintenance program on all loading equipment.

10) FERMCO should ensure that rail transportation options are protected. In particular:

(1) The availability of the rail yard at Shandon Station should be preserved through negotiation with CSX Transportation (the operating railroad). Expansion of the existing systems may be required to improve rail operations. The Shandon Station is an important railroad component in transporting FEMP waste off site. Considering the number of rail cars that will be required to move the waste material off site, the Shandon Station could be used to store empty rail cars. At present, the Shandon Station has marginal traffic and could be abandoned. The cost of repairing existing structures at the station is assumed to be the responsibility of the rail company. Ultimately, some of the cost may be passed on to the FEMP through the service contract.

(2) The availability of the rail line from Cottage Grove, Indiana to the Shandon Station yard should be preserved through negotiation with CSX Transportation. The line presently has marginal traffic levels and could be a candidate for abandonment. The FEMP is located almost at the end of the 26-mile long, dead-end line. Further, the line has several key structures, including a large, wooden trestle. If those structures became unusable it is unlikely that present traffic volumes would warrant their replacement. It may be necessary for the DOE to participate in the upkeep of the rail line or to guarantee future traffic volumes.

11) In addition to this study, other studies have provided important information regarding the remediation of waste material at the FEMP. This information should also be considered in the evaluation of all future transportation studies. The major points highlighted are as follows:

(1) The Radioactive Materials Incident Report (RMIR) Data Base is a compilation of transportation accidents/incidents that have occurred during the shipment of radioactive materials. The data base includes events from 1971 to the present. A breakdown of the types of accidents are presented in Table 5-1.

Table 5-1 - U.S. Radioactive Material Transportation Events (1971 - Present)

Mode	Transport Accidents	Handling Accidents	Other Incidents
Air	18	137	136
Courier	2	2	3
Freight	0	5	10
Highway	293	101	639
Rail	20	2	15
Warehouse	0	1	1
Water	1	4	5
Other	0	2	4
TOTAL	334	254	813

SECTION 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Risk Assessment

RADTRAN 4 calculated the accident risks associated with these shipments of waste. The higher risk per shipment is in direct relation to the number of miles travelled. While no calculations were performed to determine the risk associated with the transfer of radioactive material from the rail cars to tractor trailers for highway shipment from Las Vegas to NTS, it is likely that this transfer will significantly increase the total risk for shipping to NTS. Prior to the choice of joint rail/highway shipment of OU-1 waste to the NTS, additional calculations should be prepared to determine the extent of the additional risk and the viability of this transportation option.

From this study, it was determined that the transportation alternative that was the lowest accident risk was the highway transportation of waste to the Portsmouth, Ohio facility. Conversely, the overall highest accident risk was associated with the rail shipment of radioactive material to the NTS. Highway transportation to Portsmouth is the lowest risk. However, Portsmouth does not have a permit for a waste disposal facility. Accident risks to Portsmouth are provided for comparison purposes only. For this reason, only Envirocare and NTS will be considered for off site disposal of the FEMP wastes. Based on preliminary results established by the risk assessment (see Table 4-2), the least risk for transportation route and mode to ship wastes from the FEMP to alternative disposal sites would be the secondary route by rail to Envirocare. However, other input parameters (i.e., dispersion factors, accident severity categories, exposure duration, etc.) will need to be included in the risk model to determine other possible radiological consequences. Further detailed risk analysis is recommended.

6.2 Cost Analysis

There are several issues related to the decision making process of how to move the treated waste from the FEMP to a final disposal site. These issues include:

1) Practical logistics
2) Cost
3) Regulatory restrictions

000052

6.2.1 Practical Logistics

Many organizations around the United States are regularly shipping LSA and other types of radioactive materials (e.g., mill tailings) material to disposal sites. Although in many cases the volumes are smaller than the potential volume from FERMCO, this demonstrates that shippers and carriers (truck and rail) have been able to develop mutually acceptable shipping practices that serve their needs as well as government regulations at all levels.

To get to the point of routinely shipping waste from Fernald, a number of infrastructure issues at the FEMP need to be addressed. Depending on the mode (truck or rail) of choice, infrastructure needs inside and outside the FEMP that need addressing are as follows:

1) Maintaining the availability of the rail line to Cottage Grove, Indiana, for optimizing rail operations is required. Presently, this branch line is not used very often. The wooden branch line trestle should be maintained instead of allowing it to deteriorate. It will be more cost effective to maintain it as opposed to replacing it.

2) Improving unprotected highway/rail grade crossings near the FEMP is mandatory for safety reasons. At present, the FEMP has a number of unprotected highway and rail crossings. Given the heavy volume of traffic during transportation operations, these systems will require improvement.

3) Improvements to the local highways near the FEMP to accommodate increased truck traffic is required. Local and FEMP road improvements will be crucial to the daily operations for receiving raw materials for processing, and to transport the treated waste material off site, should off-site disposal be selected as the remediation alternative.

In general, the movement of LSA material is routine, but to handle and transport the treated waste volumes from the FEMP, both on-site and off-site infrastructure improvements as noted throughout this document are necessary.

6.2.2 Cost Results

To present cost impacts, costs were calculated for different scenarios including: two transportation modes (truck or rail), three disposal sites, three waste volumes, four container options, and two routes from the FEMP to each disposal site for three waste densities. The cost analysis does not include disposal costs or infrastructure improvements. It is noted in Section 5 that disposal costs at Envirocare range from 8 to 10 dollars/ft^3, depending on volume. It was also determined that disposal costs at the NTS are approximately 10 dollars/ft^3.

The costs presented are in 1993 dollars (unescalated) for the 10-year period for the different waste form densities. The results presented in Table 4-5 (1,000,000 yd^3 scenario for shipment to Envirocare) is approximately 363 million dollars less than rail shipment to NTS (including truck drayage costs from Las Vegas), based on current disposal practices and waste acceptance criteria for the two sites. It is therefore concluded that off-site transportation of treated wastes at the least cost would be bulk rail shipment to Envirocare. Based the cost differential, and Envirocare's ability to receive mixed waste (NTS is currently not accepting mixed waste), the shipment of the waste material in gondola rail cars to Envirocare would be the preferred transportation method.

6.2.3 Regulatory Restrictions

Regulatory restrictions (in the form of permits, fees, and routing, etc.) may exist in some transit states and will need to be compared with Federal LSA shipping requirements. The additional costs must be verified and included in the final routing equations.

SECTION 7

REFERENCES

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APPENDIX A

TRANSPORTATION ARAR LIST

Table A-1 - Off-Site Disposal of OU-1 Wastes - Summary of Federal DOT Transportation Requirements

Chemical, Location, or Action	Requirement	ARAR/TBC	Comments/Rationale
Action	49 CFR 171.2 Persons transporting hazardous materials are required to comply with Sections 106, 107, 171, 172, 173, 174, 175, 176, 178, 179, and 180.	Applicable	Compliance with container specifications, labeling, packaging, and recordkeeping requirements.
Action	49 CFR 171.3 Persons transporting hazardous waste are required to comply with Sections 171, 172, 173, 174, 175, and 176.	Applicable	Compliance with container specifications, labeling, packaging, and recordkeeping requirements.
Action	49 CFR 171.15 The DOT is to be notified when an accident occurs.	Applicable	The DOT is to be notified by the transporter "at the earliest practical moment" when an accident occurs which involves the transport of hazardous material or waste. The incident may result in injury, death, spillage, fire, etc.
Action	49 CFR 171.16 The transporter involved in an incident as described in 171.15 shall report the incident.	Applicable	Complete and file DOT Form F 4800.1 to the DOT when incident described in 171.15 occurs.
Action	49 CFR 171.21 The carrier responsible for reporting an incident shall assist the DOT investigators with the investigation.	Applicable	The carrier is to supply records and information pertinent to the incident to the DOT investigator.
Action	49 CFR 172.200 Describes the broad based definition of hazardous materials covered under this section.	Applicable	Each transporter shall describe the hazardous material on the shipping paper as required in this Subpart.
Action	**49 CFR 172.203(k)** Provides the descriptive terms to be used for "N.O.S." material.		Technical names for materials must be added next to the proper shipping name. Poisonous materials shall apply to this section. For mixtures, the technical names for at least two components most predominantly contributing to the hazards of the mixture must be entered on the shipping papers.

Note: The bold underlined text are regulations that may not apply to shipment of LSA material.

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Table A-1 - Off-Site Disposal of OU-1 Wastes - Summary of Federal DOT Transportation Requirements (Continued)

Chemical, Location, or Action	Requirement	ARAR/TBC	Comments/Rationale
Action	49 CFR 172.202 The description of the shipment contents shall meet the requirements set forth in this section.	Applicable	The description of the shipment contents shall include the name, hazard class, identification number, quantity, type of packaging, and destination.
Action	49 CFR 172.203(d) Provides the shipping requirements for radioactive materials.	Applicable	A description of radioactive materials shall include the name of each radionuclide, a description of the chemical and physical form, the activity contained in each package, and the labeling requirements for each shipment or package.
Action	49 CFR 172.203(e) The description of radioactive material is identified within this section.	Applicable	The description of radioactive materials shall include the name of each radionuclide, its physical and chemical form, activity, the category or label, and the transport index.
Action	49 CFR 172.203(g) Provides the shipping paper and placard requirements for rail transport.	Applicable	Rail cars containing hazardous materials must contain the notation "PLACARD" followed by the name of the placard required for the rail car. The shipping paper must contain the appropriate notations.
Action	49 CFR 172.203(h) Describes the marking requirements for anhydrous ammonia and liquified petroleum gas.		Anhydrous ammonia containers shall contain the words "0.2 percent water" or "Not for Q and T Tanks."
Action	49 CFR 172.203(i) Describes additional shipping paper requirements.	Applicable	Additional shipping paper requirements include: identification of packages, the number of each type of package, and the gross weight of each type of package.
Action	49 CFR 172.204 A written statement certifying the contents meet DOT requirements shall be attached to the shipping paper. The certification must be signed by the specified person.	Applicable	The required statement and signature requirements of this statement shall be met by the shipper.
Action	**49 CFR 172.205** The shipper of hazardous waste shall complete, carry, and deliver EPA Form 8700-22 and 8700-22a (when necessary).	Applicable	The shipper is required to complete EPA manifest forms and retain the forms for 3 years.

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Table A-1 - Off-Site Disposal of OU-1 Wastes - Summary of Federal DOT Transportation Requirements (Continued)

Chemical, Location, or Action	Requirement	ARAR/TBC	Comments/Rationale
Action	49 CFR 172.301 Each container of 110 gallons or less shall be required to meet the marking requirements of this section.	Applicable	Each container of 110 gallons or less shall include proper shipping name and identification numbers.
Action	49 CFR 172.304 Provides the basic requirements for all markings.	Applicable	Markings must be in English, must be displayed on a background of sharply contrasting color, must be unobscured by labels or attachments, and must be located away from any other marking that could substantially reduce its effectiveness.
Action	49 CFR 172.306[1] Provides requirements when consignee's or consignor's name and address is needed.	Applicable	Each package containing a hazardous material which is transported must be marked with the name and address of the consignee or consignor except when not transferred from one motor carrier to another. Part of the load is tendered from one consignor to one consignee or when the package is a portable tank.
Action	49 CFR 172.310 Provides the radioactive material markings necessary for transport.	Applicable	In addition to other sections of this subpart, radioactive materials require packages over 110 pounds to have their gross weight plainly marked. Type A or Type B labels plainly marked. Materials destined for export to be marked with "USA."
Action	**49 CFR 172.312** Specifies the packaging requirements for packages having an inside package containing liquid hazardous material.		The packages shall be packaged with closures upward, legibly marked "THIS SIDE UP" and action indication "THIS WAY UP."
Action	**49 CFR 172.316** Describes the marking requirements for material classified as ORM.		Packages containing 110 gallons and classified as ORM must be plainly labeled. ORM-D labels can be affixed to the shipping tag. The labeling of a package does not preclude the requirement for a certificate on a shipping paper when required by 172.200.

[1] This citation was identified as reserved per latest reference (1992 CFR).

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Chemical, Location, or Action	Requirement	ARAR/TBC	Comments/Rationale
Action	**49 CFR 172.324** Each container of 110 gallons or less which cannot be identified by proper shipping name shall meet the marking requirements of this section.		When the proper shipping name is not known for containers of 110 gallons or less, the following information shall be provided on the package: name of the hazardous substance as it appears in the Appendix to 172.101, waste stream number, EPA characteristics (ignitability, corrosivity, reactivity, EP toxicity), or the letters "RQ."
Action	49 CFR 172.400 Provides general labeling requirements for hazardous materials identified in 172.101 or 172.102.	Applicable	Each hazardous material specified in 172.101 or 172.102 requires labels as specified in this Subchapter. Labels are not required on certain cylinders of compressed gases, DOD shipments of ammunition or other materials handled by DOD personnel, containers covered under 172.512 and .514 or 172.425, and cargo aircraft only labels.
Action	49 CFR 172.401 Provides conditions under which materials which are not properly labeled should not be transported.	Applicable	Packages which are prohibited from transport are packages which confuse or conflict with a label prescribed in this part. The restrictions of this section do not apply to packages in conformance with the United Nations recommendations, International Maritime Organization, ICAO Technical Instructions, or TDG regulations.
Action	**49 CFR 172.402** Provides additional labeling requirements for multiple hazard class materials, air transport of materials, dangerous when wet materials, flammable liquid containers, etiologic agents, packages containing samples, and DOT 110 and 106 tanks.		Materials which exhibit multiple hazards shall be classified in accordance with the protocol established in this Subchapter. "CARGO AIRCRAFT ONLY" labels shall be affixed to hazardous materials offered for transport by air. Hazardous materials identified in 172.101 as dangerous when wet shall be labeled with "DANGEROUS WHEN WET" label. A "BUNG" label shall be affixed to a package containing a flammable liquid having a vapor pressure between 16 and 40 psi at 100 degrees F. "ETIOLOGIC AGENT" labels shall be affixed to etiologic agents as described in 172.444 and 172.388. Packages containing samples may be labeled according to the shipper's tentative class assignment. DOT specification 106 and 110 tanks must be labeled on each end.
Action	49 CFR 172.403 Provides the labeling requirements for radioactive materials.	Applicable	The proper "RADIOACTIVE" label must be applied to a package including the name of the radionuclide, activity, and transport index.

Chemical, Location, or Action	Requirement	ARAR/TBC	Comments/Rationale
Action	**49 CFR 172.404** Provides labeling requirements for packages containing different hazard classes.		Packages having different hazard classes packaged into the same container shall have affixed to the outside a label which identifies each of the hazard classes. When two or more packages containing compatible hazardous material are placed within the same outside container, the outside container must be labeled for each hazard class.
Action	**49 CFR 172.405** Provides label clarification for oxygen and chlorine products.		Packages containing oxygen may be labeled as "OXYGEN" or "OXIDIZER." Packages containing chlorine may be labeled as "CHLORINE" in place of "POISON" or "NON-FLAMMABLE GAS."
Action	49 CFR 172.406 Provides the general location requirements for labels on packages.	Applicable	Labels shall be affixed to packages near the market paper shipping naming, or may be printed on or affixed to a tag depending on the package size. Label borders must be of contrasting color. Labels must be displayed on at least two sides or ends, and labels must not be obscured.
Action	49 CFR 172.407 Provides the design and manufacturing specifications for hazardous material labels.	Applicable	Labels must be durable and weather resistant. Normal labels must be a certain size. Label size and color must meet the requirements of this subchapter.
Action	49 CFR 172.500 Provides placarding requirements and exceptions for people offering for transport or transporting hazardous materials.	Applicable	Any person offering for transport or transporting a hazardous material is subject to this subchapter, except for etiologic agents, ORM-A, B, C, D, E, or limited quantities in 172.203(b).
Action	49 CFR 172.502 Provides the criteria when applying placards to hazardous materials.	Applicable	Placards must be placed on transport vehicles, portable tanks, or freight containers containing hazardous materials. No signs may interfere or confuse the intent of any placard and must comply with IMDG Code or TDG regulations.
Action	49 CFR 172.504 Provides general placarding requirements to be placed on a transport vehicle, freight container, or rail car.	Applicable	The transport vehicle, freight container, or rail car shall meet the proper placarding requirement of this subpart.

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Chemical, Location, or Action	Requirement	ARAR/TBC	Comments/Rationale
Action	49 CFR 172.507 Provides provisions for placarding with "RADIOACTIVE" warning placards on transport vehicles.	Applicable	Highway route controlled quantity radioactive materials must have the required "RADIOACTIVE" warning placard.
Action	49 CFR 172.516 Requires the placard to be visible on rail car, motor vehicle, transport vehicle, portable tank, or freight container.	Applicable	Each placard on a motor vehicle or rail car must be visible from the direction it faces, except from the direction of another motor vehicle or rail car to which the motor vehicle or rail car is coupled. Placards may be placed on the front side of a truck-tractor. Placard holders must meet the specifications of Appendix C. A placard or placard holder may be hinged provided the required format, color, and legibility are maintained.
Action	49 CFR 172.600 Presents requirements of providing and maintaining emergency response information during transportation and at hazardous material facility locations used to load materials.	Applicable	Compliance with this subpart for all transporters and handlers of hazardous materials unless hazardous materials are excepted from the shipping paper requirements of this Subchapter.
Action	49 CFR 173.1 Provides general requirements to be met by shippers under Subpart A.	Applicable	Purpose and scope.
Action	49 CFR 173.2 Establishes a hierarchy of hazards when material has more than one hazard characteristic, with radioactive material being of greatest concern.	Applicable	Identify the known hazards of the material, then classify them according to this requirement.
Action	49 CFR 173.3 Provides compliance with this requirement along with inspection by the DOT, and repackaging of damaged or leaking containers.	Applicable	All hazardous material packages are eligible for inspection by the initial carrier or DOT representative. The package shall meet the requirements for all modes of transportation unless otherwise noted. Any leaking or damaged container shall be placed into a designated "salvage drum."

Table A-1 - Off-Site Disposal of OU-1 Wastes - Summary of Federal DOT Transportation Requirements (Continued)

Chemical, Location, or Action	Requirement	ARAR/TBC	Comments/Rationale
Action	49 CFR 173.7 Government agencies shall comply with this subchapter, unless otherwise noted.	Applicable	Hazardous materials transported by, for, or to the Department of Defense (DOD) shall be packaged according to the requirements of this subchapter. Radioactive materials made by or under the direction or supervision of the DOE or DOD and which are escorted, for the purposes of national security, by agency personnel are exempt from the requirements of Parts 170-189 of this subchapter.
Action	49 CFR 173.21 Restricts packaging of hazardous materials by prohibiting incompatible materials: Materials which are unstable below 130 degrees F, packages which involve a flammable gas or vapor, materials unstable in a fire, cigarette lighters, and magnetic fields of more than 0.00525 gauss.	Applicable	The shippers shall not allow the items identified in this requirement to be packaged for transportation.
Action	49 CFR 173.22 Provides criteria for packaging hazardous materials for transport and to allow shipment of fissile radioactive materials.	Applicable	General requirements.
Action	49 CFR 173.24 Provides packaging requirements under this subchapter so that contents are not released during normal transportation.	Applicable	The packaging of hazardous or radioactive materials must meet these requirements.
Action	49 CFR 173.25 Provides requirements for overpack containers for hazardous materials. Corrosives and poisons meet separate requirements of this section.	Applicable	Hazardous material containers must contain the proper markings. Corrosives must be properly labeled and secured in the overpack. Poisons must be packaged and segregated in accordance with the requirements.

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Table A-1 - Off-Site Disposal of OU-1 Wastes - Summary of Federal DOT Transportation Requirements (Continued)

Chemical, Location, or Action	Requirement	ARAR/TBC	Comments/Rationale
Action	49 CFR 173.26 Provide requirements for limited quantities to be changed form US measures to metric measures.	Applicable	Package quantities of 110 gallons or less, or only by avoirdupois weight for 1,000 pounds or less may be substituted for metric measures. When quantity limitations are not identified the permitted gross weight must be referred to in the container specifications.
Action	49 CFR 173.28 Provides conditions under which containers may be re-used for the same or different hazardous materials, and exceptions to re-use different types of containers.	Applicable	When containers are re-used they must meet the requirements of this subchapter. Containers must be cleaned, retested, and relabeled, if necessary. Exceptions to re-use include kegs of any chlorate or black powder, containers marked STC or NRC, polyethylene containers used for poisons, and anhydrous hydrofluoride acid.
Action	49 CFR 173.29 Provides requirements for transport of empty containers that once held hazardous materials.	Applicable	Empty packages are containers that once held hazardous materials which have not been cleaned. These containers (110 gallons or less) must be transported with all openings and valves closed, and labels affixed. Requirements are placed on empty portable tanks, cargo tanks, tank cars, or multi-unit tank cars.
Action	49 CFR 173.30 Provides general compliance requirements for loading and unloading hazardous materials from a transport vehicle or vessel.	Applicable	A person who loads or unloads hazardous materials into or from a transport vehicle or vessel shall comply with the applicable loading and unloading requirements of parts 174, 175, 176, and 177 of this subchapter.
Action	49 CFR 173.401 Sets forth the general requirements of this section for transportation or radioactive materials along with exceptions.	Applicable	Radioactive materials covered under this section must also meet the requirements of 10 CFR 71.
Action	49 CFR 173.411 Radioactive materials are to be packaged so that they can be easily handled and the external surface can be easily decontaminated.	Applicable	A package between 22 and 110 pounds has a means of manual handling. Packages greater than 110 pounds can be handled by mechanical means. Each lifting attachment will have a minimum safety factor. The external surface must contain minimum pockets or crevices.

Table A-1 - Off-Site Disposal of OU-1 Wastes - Summary of Federal DOT Transportation Requirements (Continued)

Chemical, Location, or Action	Requirement	ARAR/TBC	Comments/Rationale
Action	**49 CFR 173.412** Provides detailed design specifications for Type A packaging of radioactive materials.		Type A packagings are required by this subchapter to be of a minimum size, configured with no protrusions, can be decontaminated easily, maintain integrity at low and high temperatures, and during transport and potential incidents.
Action	**49 CFR 173.413** Type B packages must meet the requirements of 10 CFR 71.		Each Type B(U) or Type B(M) package must be designed and constructed to meet the applicable requirements in 10 CFR 71.
Action	**49 CFR 173.415** Provides package criteria for containers appropriate for Type A1 or A2 limits.		Packages appropriate for shipments containing A1 or A2 limits include DOT Spec 7A, DOT Spec. 55, Type B, B(U), or B(M), and foreign made Type A packaging.
Action	**49 CFR 173.416** Provides package criteria for shipments exceeding A1 or A2 limitations.		Type B packages appropriate for shipments exceeding A1 or A2 limits include DOT Spec. 55, Type B, B(U), or B(M), DOT Spec. 6M, DOT Spec. 20WC, and DOT Spec. 21WC.
Action	**49 CFR 173.418** Provides packaging requirements for pyrophoric radioactive materials.		Pyrophoric radioactive materials, not exceeding A2 limits, shall be packaged in Type A packages. These packages must be capable of passing the test conditions of 173.465 without leakage of contents.
Action	**49 CFR 173.420** Provides packaging requirements for uranium hexafluoride. These requirements are in addition to other applicable requirements of this subchapter.		Uranium hexafluoride must be offered for transport in accordance with ANSI N14.1, DOT specifications for Class 106A tank cars, ASME Code Section VIII, Division I, minimum shell and head thickness, and certain physical characteristics of uranium hexafluoride.
Action	**49 CFR 173.421** Packages which do not exceed the limits in 173.423 are excepted from the specification requirements of this subchapter if the requirements of this section are met.		Radioactive materials whose activity does not exceed the limits of 173.423 are excepted from the packaging specifications of this subchapter if the materials are securely packaged and will not leak. External surface doses do not exceed 0.5 mrem/hr. Removable surface contamination does not exceed the limits specified in 173.443(a), bears the marking "RADIOACTIVE," and otherwise is prepared as specified in 173.421-1.

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Table A-1 - Off-Site Disposal of OU-1 Wastes - Summary of Federal DOT Transportation Requirements (Continued)

Chemical, Location, or Action	Requirement	ARAR/TBC	Comments/Rationale
Action	**49 CFR 173.421-1** Provides additional requirements for excepted radioactive materials identified under 173.421.		Excepted radioactive materials must be certified as being acceptable for transportation. The following sections apply to this material: 171.15, 171.16, 173.448(f), 174.750, 176.710, 177.861, 175.45, and 175.700(b), 154.700(c).
Action	**49 CFR 173.421-2** Provides the classification and packaging of a limited quantity of radioactive material according to its other hazards.		Limited quantity radioactive materials which meet the definition of another hazard class or ORM-A, B, or C, or is a combustible liquid, shall be classified as such. Those materials are excepted from the requirements of 173.421-1(a), 172.203(d), and 172.204(c) (4) with proper notation on shipping papers. The material may not be offered for transportation aboard a passenger-carrying aircraft.
Action	49 CFR 173.425 Provides transport requirements for LSA material.	Applicable	LSA materials will be transported in a DOT spec 7A Type A package. LSA material consigned as exclusive use shall meet certain requirements. Bulk shipments shall be transported in closed transport vehicles.
Action	49 CFR 173.427 Provides exceptions and requirements for empty packages once holding radioactive materials.	Applicable	Empty radioactive materials packages are excepted from shipping papers and certification, marking, and labeling requirements of this subchapter if the packaging meets the requirements of 173.421(b), (c), and (e), 173.421-1, securely closed so that there will be no leakage, internal contamination does not exceed 100 times the limits of 173.443, and that "empty" labels meet the requirements of 173.450 and other labels are covered, removed, or obliterated.
Action	**49 CFR 173.431** Provides radioactivity limits for Type A and Type B packages.	Applicable	Type A packages shall not exceed the radioactivity limits listed in 173.435 or as determined in accordance with 173.433. Type B, B(U), or B(M) packages shall not exceed the limits prescribed in 173.416.

Table A-1 - Off-Site Disposal of OU-1 Wastes - Summary of Federal DOT Transportation Requirements (Continued)

Chemical, Location, or Action	Requirement	ARAR/TBC	Comments/Rationale
Action	49 CFR 173.441 Provides radiation level limitations for packages under this subchapter.	Applicable	Each package of radioactive materials offered for transport shall be designed and prepared so that the external radiation levels do not exceed 200 mrem/hour and the transport index does not exceed 10. Packages which exceed these limits shall be transported by exclusive use shipment only and shall not exceed the limits prescribed in this section. The shipper shall provide written instructions for maintenance of the equipment controls to the carrier. Packages exceeding radiation levels or transport index shall not be transported by aircraft.
Action	49 CFR 173.442 Provides requirements for thermal limitations of packages which are designed, constructed, and loaded with radioactive material.	Applicable	Each package shall be designed, constructed, and loaded so that the heat generated within the package does not affect the integrity of the package, and the external surface does not exceed the limits of this section.
Action	49 CFR 173.443 Provides external radioactive contamination levels for packages during transport.	Applicable	Removable contamination on the external surface of a package shall be kept as low as achievable and within the limits of Table 10 of this section. Exclusive use shipment limits are set at 10 times the Table 10 limits. The transport vehicle limit is .5 mrem/hour. Portions of this section do not apply to closed transport vehicles if they meet the requirements of this section.
Action	49 CFR 173.444 Provides the labeling requirements for radioactive materials.	Applicable	Each package of radioactive material, unless excepted by 173.421, 173.422, 173.424, 173.425(b), or 173.427 shall be labeled as provided in Subpart E of Part 172 of this subchapter.
Action	49 CFR 173.446 Refers to placarding requirements for radioactive material.	Applicable	Refers to Subpart F of Part 172 of this subchapter.
Action	49 CFR 173.447 Provides temporary storage requirements, except to NRC or Agreement State licensed facilities or U.S. Government owned or constructed facilities.	Applicable	Packages applicable to this section bearing Radioactive Yellow II or Radioactive Yellow III labels shall not be stored in any one area where the total transport indexes exceed 50. Groups of packages must be stored to maintain a spacing of at least 20 feet from other package groups containing radioactive materials.

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Table A-1 - Off-Site Disposal of OU-1 Wastes - Summary of Federal DOT Transportation Requirements (Continued)

Chemical, Location, or Action	Requirement	ARAR/TBC	Comments/Rationale
Action	49 CFR 173.448 Provides general transportation requirements for radioactive materials.	Applicable	Compliance with general transportation requirements for radioactive materials includes: prevention of shifting loads during transport, materials may be carried with general cargo, not allowed in passenger areas except designated compartments, mixing of different kinds of fissile packages is allowed, transport index limitations on passenger aircraft, and overpack limitations.
Action	**49 CFR 173.461** Provides compliance test requirements for Sections 173.463 through 173.469.		Packages must be in test compliance with Sections 173.463 through 173.469.
Action	**49 CFR 173.462** Provides specifications for the preparation of specimens for testing.		Each specimen to be tested must be examined for the requirements identified in this section. The containment system shall be clearly specified, and the external feature of the specimen shall be clearly identified.
Action	**49 CFR 173.463** Provides requirements for testing the integrity of packaging and shielding (if applicable) following testing.		After tests specified in 173.465 and 173.466 the integrity of the packaging or of the packaging and shielding shall be retained in accordance with 173.412(m).
Action	**49 CFR 173.465** Provides tests which must be conducted for Type A packaging.		Proposed packagings with contents must be capable of withstanding the following tests: water spray test, free drop test, compression test, and the penetration test.
Action	**49 CFR 173.469** Provides testing requirements for special form radioactive materials.		Special form radioactive material must be tested so that it is representative of the actual solid material or capsule which will be transported. The tests include impact, percussion, bending, heat, and leachability.
Action	49 CFR 173.474 Provides quality control checks of packagings prior to first use.	Applicable	The shipper shall check any package prior to first use for design and construction, and for effectiveness of the shielding, containment, and heat transfer characteristics as specified in this subchapter.

Table A-1 - Off-Site Disposal of OU-1 Wastes - Summary of Federal DOT Transportation Requirements (Continued)

Chemical, Location, or Action	Requirement	ARAR/TBC	Comments/Rationale
Action	49 CFR 173.475 Provides quality control of packages prior to each shipment.	Applicable	The shipper shall ensure that the packaging is proper for the contents, in good physical condition, each closure device is free of defects, fissile material moderators and absorbers are present (if required), special instructions have been followed, leak tests have been conducted, internal pressure is within limits, and external radiation levels are acceptable.
Action	**49 CFR 173.476** Requires the shipper of special form radioactive materials to file safety analysis with the RSPA safety analysis and requires exporters to comply with the form requirements of this section.		Shippers are required to file with the RSPA safety analysis and any test results. Exporters are required to obtain a Competent Authority Certificate.
Action	49 CFR 174.3 A shipment of hazardous materials that is not prepared in accordance with Parts 171, 172, and 173 may not be accepted for transportation by rail.	Applicable	Compliance with the requirements of Part 174.
Action	DOE 5820.2A III.3.G Requirements for shipping low-level waste	TBC	Volume and number of shipments to be minimized. Off-site shipment shall be in compliance with DOE 1540.1. Generators to provide annual forecast in third quarter of fiscal year to disposal facilities receiving the waste. Generators must have advance approval from receiver before shipment. Each package must comply with labeling requirements of DOE 1540.1.
Action	**DOE 5820.2A IV.2** Management of byproduct containing waste consistent with guidelines of 40 CFR 192.		Does not specifically mention transportation.

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Table A-2 - Off-Site Disposal of OU-1 Wastes Summary of State Transportation Requirements

State	Requirement	Comment/Rationale
Ohio*	ORC Part 3734 ORC Parts 3745, 3701, 4901	Substantially similar to Federal requirements, with additional requirement of transporter registration. Hazardous material transportation requirements substantially equal to 49 CFR.
Indiana	329 IAC 3	No additional hazardous waste or hazardous material transportation requirements beyond Federal regulations.
Illinois*	92 IAC 107.1 - 180.2000 35 IAC 722, 723, 700, 809 32 IAC 340, 606	No additional hazardous waste or hazardous material transportation requirements beyond Federal regulations. A permit is required for hauling "special" wastes.
Missouri*	10 CSR 25-5.262 10 CSR 25-13.010 10 CSR 25-6.263	Hazardous waste transporters must obtain license, carry minimum insurance coverage, and pay a fee. PCB material must be carried by hazardous waste transporters. Hazardous material requirements are substantially equal to 49 CFR.
Iowa*	761 IAC 520.1 -.4 641 IAC 39.1 - .5	No additional hazardous waste or hazardous material transportation requirements beyond Federal regulations. Licensing required for radioactive waste with specific activity above 0.002 uCi/g.
Nebraska	128 NAC 3,17	No additional hazardous waste or hazardous material transportation requirements beyond Federal regulations.
Kansas*	KAR 28-31-4, 6, 7 KAR 28-35-231 KAR 82-4-01, 03, 8a, 20, 38	Hazardous waste transporters must be registered, have minimum insurance coverage, and travel preferred routes. Hazardous material transportation requirements are substantially equal to 49 CFR.
Oklahoma		No additional hazardous waste or hazardous material transportation requirements beyond Federal regulations.
Texas	16 TAC 5 31 TAC 335 37 TAC 3	No additional hazardous waste or hazardous material transportation requirements beyond Federal regulations.

Table A-2 - Off-Site Disposal of OU-1 Wastes Summary of State Transportation Requirements (Continued)

State	Requirement	Comment/Rationale
Wyoming*		No additional hazardous waste or hazardous material transportation requirements beyond Federal regulations. Radioactive waste transport requires a permit.
Colorado*	8 CCR 1507 6 CCR 1007	Hazardous material transporters must register and obtain a permit. Municipalities may also require permits. Routing is also controlled. Other hazardous waste and hazardous material requirements are similar to Federal.
New Mexico		No additional hazardous waste or hazardous material transportation requirements beyond Federal regulations.
Utah	UAC R450 UAC R313 UAC R909	No additional hazardous waste or hazardous material transportation requirements beyond Federal regulations.
Arizona	AAC R17-4 AAC R18-8	No additional hazardous waste or hazardous material transportation requirements beyond Federal regulations.
Nevada*	NRS 459	Permit required for hazardous waste and material and notice required for transportation of radioactive waste. Government exempted from compliance.
California*	13 CCR 1150-97 26 CCR 13-1150 - 13-1216	Hazardous waste transporters must be registered, have minimum insurance coverage, and file disclosure statements. Hazardous material transportation requirements are substantially equal to 49 CFR.

* See Appendix B for special requirements, forms, etc.

APPENDIX B

TRANSPORTATION LEGISLATIVE DATA BASE
(ADDITIONAL STATE STATUTES)

6375 - -

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Compendium of Federal and State Radioactive Materials Transportation Laws and Regulations: Transportation Legislative Data Base (TLDB)

October 1989

Office of Transportation Systems and Planning
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Transportation Legislative Data Base

Item Number: ST-0132

Action Type: STATUTE

Source: FEDERAL

State:

Citation: 45 USC Sections 421-441

Title: FEDERAL RAILROAD SAFETY ACT

Transport Mode: RAIL

Regulatory Authority: DEPARTMENT OF TRANSPORTATION (DOT)

Issues:
- INSPECTION AND ENFORCEMENT
  - Regulations - Requirements
  - Responsibilities and Capabilities
  - Financial Support
- INFRASTRUCTURE IMPROVEMENTS
  - Rail Conditions
- REGULATIONS

Summary

All facets of railroad safety are subject to DOT regulation under the Federal Railroad Safety Act of 1970 (FRSA), which provides that railroad safety regulation shall be nationally uniform to the extent practicable. See 45 USC, Sections 421-441. Under the FRSA, a State may adopt or enforce railroad safety regulations provided that the regulations are compatible with Federal regulations, necessary to eliminate or reduce an essentially local safety hazard and not unduly burdensome on interstate commerce (see 45 USC sec. 434). As relevant to the DOE shippers who prepare material for rail transport must comply with the DOT regulations in 49 CFR Part 173 before presenting a nuclear materials shipment to a carrier.

Comments:

AUTHORIZED REGULATIONS ARE SUMMARIZED IN TLDB ENTRY AR-0041.

000076

Transportation Legislative Data Base

Item Number: AR-0043

Action Type: REGULATION

Source: FEDERAL

State:

Citation: 49 CFR Parts 350-398

Title: FEDERAL MOTOR CARRIER SAFETY REGULATIONS (UNOFFICIAL)

Transport Mode: MOTOR VEHICLE

Regulatory Authority: FEDERAL HIGHWAY ADMINISTRATION (FHWA)

Issues:
- DRIVER - OPERATOR TRAINING
  - Regulations - Requirements
  - Qualifications
  - Training
- INSPECTION AND ENFORCEMENT
- INSURANCE - LIABILITY
- INCIDENT NOTIFICATION
  - Regulations - Requirements
  - Methods
  - Timing
  - Responsibility
- TRANSPORTATION OPERATIONS

Summary

FHWA motor carrier safety requirements are contained in the referenced regulations. FHWA is part of DOT. See 49 CFR Parts 350-398. These regulations pertain to both hazardous (including nuclear) and nonhazardous motor carrier safety. As relevant to nuclear transportation, these regulations address, among other things, minimum levels of financial responsibility for motor carriers ($5 million insurance for nuclear carriers per 49 CFR Section 387.11), driver qualifications (49 CFR Part 391), accident

notification and reporting (49 CFR Part 394), and driving and parking rules for hazardous materials transportation (including some applicable and some inapplicable to nuclear materials) (49 CFR Part 397).

Comments:

IMPLEMENTS MOTOR CARRIER SAFETY ACT (TLDB ENTRY ST-0179).

000078

Transportation Legislative Data Base

Item Number: AR-0006

Action Type: REGULATION

Source: STATE

State: Colorado

Citation: Colorado Public Utility Commission Nuclear Materials Transportation Regulations (Unofficial)

Title: NUCLEAR MATERIALS TRANSPORTATION REGULATIONS (UNOFFICIAL)

Transport Mode: MOTOR VEHICLE

Regulatory Authority: PUBLIC UTILITY COMMISSION
STATE PATROL

Issues:
- ROUTING
  - Motor Vehicle
  - Designation Criteria
  - Interagency Cooperation
- SHIPMENT NOTIFICATION
  - Pre-Notification
- DRIVER - OPERATOR TRAINING
- INSPECTION AND ENFORCEMENT
- INSURANCE - LIABILITY
- INCIDENT NOTIFICATION
- PERMITS
  - Carrier Permit
- TRANSPORTATION OPERATIONS
- REGULATIONS
  - Adoption of Federal Regulations
  - Consistency with Federal Regulations
- FEES

Summary

The Colorado Public Utility Commission has promulgated rules and regulations governing the transportation of nuclear materials in Colorado pursuant to Colorado Revised Statute Sections 40-2.2-101 through 40-2.2-213 (see TLDB entry ST-0015). Rule 5 (inspections) requires that all nuclear materials shipments entering the State on public roads must be inspected by personnel at the port of entry or by the Colorado State Patrol at the weigh station nearest the point of entry. All nuclear materials shipments originating within the State must be inspected by the Colorado State Patrol at the point of origin. All drivers, motor vehicles, and cargo must be in compliance with 49 CFR Parts 171, 172, 173, 177, and 178, and 49 CFR Parts 390-398 and Colorado Nuclear Transportation Rule 7. Inspection procedures are to be in accordance with those of the Commercial Vehicle Safety Alliance.

Transportation Legislative Data Base

Item Number: AR-0053

Action Type: Regulation

Source: STATE

State: Colorado

Citation: Colorado Department of Public Safety, Division of State Patrol HMR 1 - HMR 7

Title: HAZARDOUS MATERIALS TRANSPORTATION REGULATIONS (UNOFFICIAL)

Transport Mode: MOTOR VEHICLE

Regulatory Authority: DEPARTMENT OF PUBLIC SAFETY, DIVISION OF STATE PATROL

Issues:
ROUTING
- Motor Vehicle
- Regulations
- Designation Criteria
- Interjurisdictional Cooperation

EMERGENCY RESPONSE
INCIDENT NOTIFICATION
- Timing

SHIPMENT RESTRICTIONS
REGULATIONS

Summary

The Colorado Department of Public Safety, Division of State Patrol, has promulgated regulations regarding, among other things, hazardous materials route designations pursuant to Colorado Rev. Stat. Sections 43-5-101 et seq. (Supp. 1987) [See TLDB entry ST-0141]. Hazardous materials regulation (HMR) 1 requires State, county, or local governmental authorities making application to the Patrol for a hazardous materials route designation pursuant to Colorado Rev. Stat. Section 43-6-302 to submit a petition for such route designation to the Patrol on or before July 1, 1988. A hazardous materials route

designation petition package was distributed on January 7, 1988. The petition must include analyses of all feasible routes within its jurisdiction.

HMR 4 provides that changes in the original information used to evaluate the risk associated with an approved route must be communicated to the Patrol. The Patrol will periodically review the status of designated routes to determine whether the approval terms specified in Colo. Rev. Stat. Section 43-6-302(8)(a) continue to be met.

HMR 6 requires that copies of reports concerning incidents or accidents involving motor vehicles transporting hazardous materials that occur within a local governmental authority's jurisdiction be forwarded within 45 days to the Patrol. HMR 7 requires that local governmental authorities petitioning for route designations must provide the Patrol with certain specified information on hazardous materials emergency response services within their jurisdiction.

Comments:

IMPLEMENTS COLORADO HAZARDOUS MATERIALS TRANSPORTATION ACT (TLDB ENTRY ST-0141).

Transportation Legislative Data Base

Item Number: AR-0074

Action Type: REGULATION

Source: STATE

State: Nevada

Citation: Nevada Admin. Code Sections 705.310 et seq.

Title: RAIL TRANSPORTATION OF HAZARDOUS MATERIALS REGULATIONS (UNOFFICIAL)

Transport Mode: RAIL

Regulatory Authority: PUBLIC SERVICE COMMISSION

Issues:
Transport Permit
Material Handling
Other
Adoption of Federal Regulations
Transport Permit Fees

Summary

The Nevada Public Service Commission has promulgated regulations regarding the transportation of hazardous (including radioactive) material by rail. See Nevada Admin. Code Section 705.310 et seq. (January 1987 version). These regulations require a permit to load or unload hazardous material onto or from railroad property, to transfer hazardous material from railroad property to another means of transportation, or to store hazardous material on railroad property without a permit issued by the Commission. See Section 705.320. The permit application must include, among other things, a map of the proposed site for loading, unloading, transfer or storage; a summary of any hazardous materials releases during the preceding 12 months; and an outline of the procedures to be used in the loading, unloading, transfer or storage of the hazardous material. The permit fee is $200. See Section 705.330. In evaluating the permit application, the Commission will consider, among other things, the proximity

of the proposed site to heavily traveled highways. See Section 705.340. DOT hazardous materials transportation regulations in 49 CFR Parts 171-174 are adopted by reference. See Section 705.380.

Transportation Legislative Data Base

Item Number: AR-0024

Action Type: REGULATION

Source: STATE

State: New Mexico

Citation: New Mexico Environmental Improvement Division Regulations 1-101 to 12-300 (Unofficial)

Title: NUCLEAR MATERIALS LICENSING AND TRANSPORTATION REGULATIONS (UNOFFICIAL)

Transport Mode: MOTOR VEHICLE

Regulatory Authority: ENVIRONMENTAL IMPROVEMENT DIVISION

Issues: ROUTING
- Motor Vehicle
- Regulations
- Designation Criteria

INSPECTION AND ENFORCEMENT
INSURANCE - LIABILITY
INCIDENT NOTIFICATION
REGULATIONS
MATERIALS LICENSING

Summary

The New Mexico Environmental Improvement Division has promulgated regulations (effective October 1981) concerning nuclear materials licensing and transportation pursuant to New Mexico Stat. Ann. Sections 74-3-1 et seq. (see TLDB entry ST-0078). See Radiation Protection Regulations 1-101 to 12-300. Except as provided in Rule 3-800, the regulations are inapplicable to common and contract carriers subject to DOT or Postal Service regulations. See Rule 1-110B. DOE prime contractors performing work at Government-owned or controlled sites, including transporting sources of radiation to or from

such sites are further exempt. See Rule 1-110D. Rule 3-700 contains radioactive materials preparation regulations, which, by their terms, do not apply to DOT or Postal Service-regulated transportation.

Rule 3-800 requires a specific license of the carrier to transport nuclear waste on New Mexico highways. The license application must contain, among other things, a statement of Federal law compliance; evidence of sufficient financial protection; and a statement of the origin, destination, and proposed routes for transportation. In approving routes, the Division is required to consult with affected local subdivisions and the State Transportation Department. See Rule 3-800D. To promote the objective of safest possible transport, vehicles carrying nuclear waste are required, to the extent practicable, to travel on interstate highways; use routes that minimize travel time; avoid traveling through or near heavily populated areas; avoid tunnels, narrow streets and alleys; avoid areas adjacent to large numbers of people; avoid stops in populated areas; and avoid hazardous road conditions due to climatic or structural conditions. See Rule 3-800E. Carriers are required to report nuclear incidents to the Division verbally as soon as practicable after the incident and in writing within 24 hours after that. See Rule 3-800G.

Comments:

IMPLEMENTS NEW MEXICO RADIATION PROTECTION ACT (TLDB ENTRY ST-0078).

Transportation Legislative Data Base

Item Number: ST-0242

Action Type: STATUTE

Source: STATE

State: Wyoming

Citation: Chapter 109 of the 1989 Laws of Wyoming

Title: PACIFIC STATES AGREEMENT ON RADIOACTIVE MATERIALS TRANSPORTATION MANAGEMENT

Transport Mode: UNSPECIFIED

Regulatory authority: PUBLIC SERVICE COMMISSION
INTERSTATE COMMITTEE

Issues:
- ROUTING
  - Regulations
  - Designation Criteria
- EMERGENCY RESPONSE
  - Responsibilities and Capabilities
- INSPECTION AND ENFORCEMENT
  - Regulations - Requirements
  - Responsibilities and Capabilities
- INSURANCE - LIABILITY
  - Insurance Requirements and Limitations
  - Liability Requirements and Limitations
- PERMITS
  - Carrier Permit
- TRANSPORTATION OPERATIONS
  - Material Preparation
- REGULATIONS
  - Consistency with Federal Regulations

Summary

This statute establishes a committee comprised of representatives from each party State to facilitate cooperation between the States on emergency response and to coordinate activities by the States to eliminate unnecessary duplication of regulations regarding the transportation and handling of radioactive materials shipments. See Chapter 109 of the 1989 Laws of Wyoming. Party States include Idaho, Oregon, Washington, and Wyoming. The model standards must not conflict with Federal law or regulation and would require a carrier to provide, among other things, the mode, route, and schedule of transportation; proof of compliance with Federal, State, and local radioactive materials transportation rules and regulations; and proof of compliance with Federal and State liability insurance requirements. Consistent with pertinent Federal law or regulations, the party States would also agree to develop model uniform procedures for issuing permits to carriers, record keeping, safety standards, routing, emergency planning, placarding, and State inspection.